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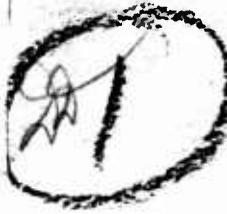
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Report No.
TOR-669 (A6107-25)-1

This report supersedes and replaces ATM-65(A5107-25)-1
dated 1 July 1965



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A PRELIMINARY STUDY OF THE MOL HSQ RECOVERY PROBLEM

1 AUGUST 1965

Prepared by

W. G. Gaskill

MOL PROJECT OFFICE

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Prepared for
COMMANDER, SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
LOS ANGELES AIR FORCE STATION
Los Angeles, California

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EASTERN TEST RANGE OFFICE

● AEROSPACE CORPORATION
Contract No. AF 04 (695)-669 ✓

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Report No.
TOR-669(A6107-25)-1
Revision 1
26 August 1965

Transmittal Sheet
For
Revision 1
Report No. TOR-669(A6107-25)-1

1. Page changes necessary to complete Revision 1 are attached and should be incorporated into the basic document.

Pages to be removed	Pages to be added
Title page A-4	Title page A-4

2. Retain this transmittal sheet in the front of the report as a record of changes made.

Report No.
TOR-669(A6107-25)-1
Revision 1
26 August 1965

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MOL HSQ RECOVERY PROBLEM

Prepared by

W. G. Gaskill
MOL Project Office

Eastern Test Range Office
AEROSPACE CORPORATION
Patrick Air Force Base, Florida

Contract No. AF 04(695)-669

1 August 1965

(Supersedes and replaces ATM-65(A5107-25)-1 dated 1 July 1965)

Prepared for

COMMANDER, SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
Los Angeles Air Force Station
Los Angeles, California

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3. METRIC TRACKING

Equipment	Existing	Programmed
AN/TPQ-18 Radar (C-Band)*	1	
FPS-16 Radar	1	

4. DATA HANDLING

Equipment	Status Existing	Programmed
<u>Computer System 1206</u>		
Computer, Univac 1375 (Mod to 1376)	1	
Tape Unit, Computer, Univac 1246 (2-transports)	1	
Converter, Main Digital/ Analog MILGO, 1576C	1	
Converter, Digital, MILGO 1623-16A	1	
Converter, Synchro, MILGO 1623-4A	1	
Converter, Digital/TTY MILGO 165B	1	
Buffer, Raw Data, MILGO 1623-1A	1	
Buffer, Output, MILGO 1623-2A	1	
Tape Recorder, Raw Data, MILGO 1585	1	
Readout Display, Range, MILGO 1641-20	2	
Line Printer, Univac 250M	1	

*Figure A-1 shows the shadow pattern for the TPQ-18 Radar at Station 12.

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A PRELIMINARY STUDY OF THE
MOL HSQ RECOVERY PROBLEM,

(9) Technical operating report,

Prepared by

(10) W. G. Gaskill
MOL Project Office

Eastern Test Range Office
AEROSPACE CORPORATION
Patrick Air Force Base, Florida

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(15)

Contractor AF 04(695)-669

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A PRELIMINARY STUDY OF THE MOL
HSQ RECOVERY PROBLEM

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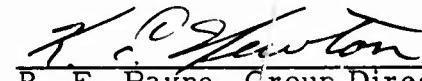


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Office

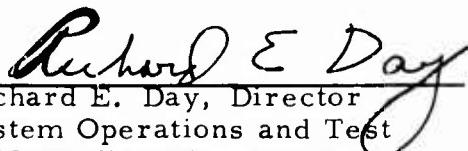
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The information in a Technical Operating Report is developed for a particular program and is therefore not necessarily of broader technical applicability.

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I. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A. HSQ FLIGHT TEST

The Manned Orbital Laboratory (MOL) Heat Shield Qualification (HSQ) Flight Test will be conducted from the Cape Kennedy Air Force Station (CKAFS) in October 1966. The HSQ flight will be initiated from a Titan III-C complex and terminated in the Air Force Eastern Test Range (AFETR) Station 12 area near Ascension Island where recovery of the modified Gemini spacecraft will be effected.

B. HSQ RECOVERY LOCATION AIDS

1. RADIO

As presently planned, the HSQ spacecraft electronic location aids will consist of two VHF/UHF radio transmitters. These will be the standard Gemini UHF Recovery Beacon transmitting a specialized homing signal on the 243.0 mc International Distress Frequency and a VHF telemetry transmitter programmed to continue operation after the spacecraft landing. As presently planned, the telemetry transmitter will be switched to a "recovery homing mode" at main parachute deployment and in this mode will transmit an unmodulated carrier on a frequency of 230.3961 mc.

2. VISUAL

The visual aids will consist of a dye marker and a high-intensity xenon discharge lamp.

C. RECOMMENDED RECOVERY AREA

It is recommended that the HSQ Planned Recovery Area (a 200 x 50 nautical mile rectangle) be centered 50 nautical miles southwest of Ascension Island. The data required by AFETR Range Safety prior to approval of this area are outlined and the wave climatology is analyzed to show that prohibitive sea conditions will be encountered no more than 20 percent of the time.

D. RECOVERY FORCE DEPLOYMENT

An analysis of the search and retrieval problem shows that deployment of one Range Instrumentation Ship, two AFETR telemetry and search aircraft, two ARS HC-130H Rescue Aircraft and two ARS HH-3C Helicopters (1 ship, 4 aircraft, 2 helicopters) is adequate to provide pararescue team access to the HSQ spacecraft within 1 hour after landing and retrieval of the spacecraft within 8 hours after landing.

E. HELICOPTER DEMONSTRATION

It is concluded that Air Rescue Service (ARS) helicopters should be used for HSQ retrieval to gain experience applicable to the final MOL/Gemini B recovery problem. Several equipment and operational problems presently prevent a demonstration of the ARS HH-3C Helicopter capability to lift and transport the HSQ spacecraft. An effort to solve these problems prior to a final decision to utilize helicopters for the HSQ retrieval operation is outlined and recommended.

F. RECOVERY TRAINING EXERCISES

Training for the HSQ recovery operation should consist of two basic efforts: an early uprange exercise to develop, standardize, and document techniques and equipment; and a final "dress rehearsal" exercise in the actual recovery area a few days before the HSQ flight test.

G. HSQ RECOVERY AGE

The major items of downrange recovery Aerospace Ground Equipment (AGE) are identified and discussed. These should consist of boilerplate spacecraft and recovery beacon simulators for recovery training and the necessary flotation collars, lifting slings, cradles, and dollies for post-retrieval handling. Downrange kits for spacecraft deactivation and postflight analysis as well as Hypergolic/Environmental Health are identified. It is emphasized that short leadtime requirements for additional recovery AGE can be expected and in view of this it is recommended that contractual provisions be made to permit rapid contractor response to equipment requirements generated within the AFETR Recovery Working Group.

II. HSQ SPACECRAFT SYSTEMS

A. INTRODUCTION

The USAF MOL Program envisions use of existing Titan III and Gemini technology and hardware to orbit a space laboratory for the purpose of evaluating man's capability to perform military missions in space.

In an effort to provide early verification of the Titan III-C payload capability, launch environmental data, and flight test verification of certain required hardware modifications, an early suborbital flight test from the CKAFS is planned for October 1966.

B. HSQ MISSION SYNOPSIS

The HSQ Flight Test (Reference 1) will involve boosting a simulated laboratory structure and a modified Gemini spacecraft (the NASA GT-2 vehicle) into suborbital trajectory from the CKAFS with subsequent reentry and recovery of the spacecraft in the Ascension Island (AFETR Station 12) area.

The simulated laboratory section will consist of a T-II Stage 1 oxidizer tank modified to represent the baseline MOL dimensions and stiffened with stringers to duplicate baseline MOL rigidity. The reentry vehicle will be the NASA GT-2 system with the heat shield modified to incorporate a hatch. Rerorockets will not be carried, thus eliminating the capsule abort capability during this flight test. The mechanical-electrical interface will be minimized in that the Gemini will provide its own instrumentation system and the mechanical interface between the Laboratory segment and the Gemini adapter will utilize the 20-bolt mating ring presently used for the Gemini/T-II interface.

The HSQ Flight Test will be initiated from Complex 40, CKAFS, with the suborbital trajectory terminating in the AFETR Station 12 (Ascension Island) area. The launch azimuth will be 106° T with trajectory lofted but

constrained within the normal Gemini abort ceilings. The flight path angle will be depressed below the local horizontal at insertion to affect the desired reentry heating. At transtage engine shutdown, Gemini separation will occur and spacecraft turnaround will be accomplished. Subsequent to reentry, the Gemini landing system will be deployed and recovery will be effected to permit engineering analysis of the Gemini heat shield modifications.

C. HSQ/GEMINI RECOVERY SYSTEM

1. GENERAL

The HSQ spacecraft (GT-2) will consist of two major structural assemblies; the Reentry Module (REM), and the adapter module. The REM construction is of the semimonocoque type using a titanium basic structure with rené and beryllium shingles. Dimensions are as follows:

Length Overall	including adapter	186 inches	(15.5 feet)
	w/o adapter	130.5 inches	(10.9 feet)
Heat Shield Diameter		90.0 inches	(7.5 feet)
Adapter Diameter		120.0 inches	(10.0 feet)
Weight (recovery - wet)		6,000 pounds (approx)	
Weight (recovery - dry)		4,000 pounds (approx)	

2. REENTRY

The reentry module is comprised of three primary structural sections. These are the Cabin section, the Reentry Control System (RCS) section, and the Rendezvous and Recovery (R&R) section. A crewman simulator equipment pallet (Reference 2) will be included in the Gemini cabin section to accomplish the necessary automatic sequencing of mission functions which would normally be performed by the Gemini crew. The modified crewman simulator will be installed in a deactivated ejection seat.

After Gemini separation from the T-III launch vehicle, the turn-around maneuver will be initiated by the crewman simulator, referencing the inertial platform. The inertial platform will be operative from lift-off through reentry until the 10,600-ft barostat signal is received prior to landing. The turnaround maneuver will be accomplished through the use of the RCS. The RCS will also be used to perform rate damping during and after separation and to roll the spacecraft for a full-lift reentry maneuver which will be continued until the time of pilot parachute deployment.

The control system consists of the attitude control electronics (ACE) and the associated controls and displays. A specially added 0.05g sensor will sense reentry and switch to the reentry control mode. A sequence output will provide the required signal for the yaw turnaround and initiation of the full-lift maneuver.

3. DECELERATION AND LANDING

The deceleration and landing system basically consists of a pilot parachute and a main parachute with the associated risers, bridles, mortar assemblies, disconnect devices, and control systems. (The HSQ mission will not use the drogue parachute normally employed for NASA/Gemini missions.)

The landing squib bus (Reference 3) is armed 5.5 seconds after adapter module separation. Operation of the barostat at an altitude of 10,600-ft will energize the nose fairing ejector squibs, the pilot parachute mortar squibs, the R&R section separation time delay, the main parachute single point disconnect time delay, and the main parachute bridle disconnect time delay. Energizing the nose fairing ejector squib separates the nose fairing from the reentry module. Energizing the pilot parachute mortar squibs initiates a 0.5-second time delay which subsequently fires the pilot parachute mortar. The pilot parachute is mortared in a reefed condition in which it remains until 6 seconds after line stretch, at which time disreefing occurs. As the pilot parachute pulls the R&R section away from the reentry module, (2.5 seconds after initiation of the separation time delay) the main parachute deploys from the open end

of the R&R canister. The main parachute deploys in a reefed condition and is attached at the single point attach fitting. At line stretch, the 10-second delay reefing line cutters are initiated. The single-point attachment will be released 22 seconds after R&R section separation and the reentry module will be suspended from the 2-point bridle support. This action positions the reentry module in the desired 35° nose-up attitude for subsequent water landing at a velocity of approximately 30-feet per second. The main parachute will be released from the reentry module by a timer switch which actuates 10 minutes after main parachute deployment.

4. RECOVERY AIDS

The HSQ spacecraft recovery location aids (Reference 2) as presently configured consist of two radio transmitters, a high-intensity flashing light, and a yellow-green fluorescein dye marker. The primary recovery location aid is a UHF radio transmitter which provides line-of-sight signals on the 243.0 megacycle International Distress Frequency.

This system and the secondary location aids are described in the following paragraphs.

a. UHF Recovery Beacon

The purpose of the UHF Recovery Beacon is to provide line-of-sight radio signals to search aircraft equipped with suitable UHF receivers and direction finding instrumentation. The radio system consists of seven major components. These are a spike eliminator, a regulator, a dc to dc converter, a pulse coder, a modulator, a transmitter, and an antenna. The system receives its power from the spacecraft main batteries through the main bus. The power is fed through a spike eliminator to the regulator which provides regulated 12-vdc power for the dc to dc converter, the transmitter tube filaments, and the pulse coder. The solid state dc to dc converter provides two high-voltage outputs for the transmitter and the modulator. The pulse coder, also a solid state device, applies correctly coded high-voltage pulses to plate modulate the transmitter power amplifiers. The resulting RF signal is double-pulse amplitude modulated with a peak pulse

power of 60 watts and a residual CW power of 0.75 watt. The pulse group consists of two pulses which are each 30-microseconds wide with a 130-microsecond spacing between pulses. The pulse group repetition rate is 200-groups per second. This pulse spacing and repetition rate provide compatibility with the SARAH receiver/direction finders and the residual CW signal provides compatibility with the AN/ARA-25 airborne direction finders installed in many military aircraft.

The UHF Recovery Beacon is activated after R&R section separation when the Gemini spacecraft changes from single-point to double-point parachute suspension. At this time the self-erecting UHF Recovery Beacon Antenna is released from its stowed position under the main parachute cable trough cover and main bus power is supplied to the transmitter. The transmitter operates continuously for 12 hours or until it is deactivated after spacecraft recovery.

b. Secondary Radio Aid

In addition to the UHF recovery beacon described above, the HSQ spacecraft will be equipped with a secondary system capable of providing a VHF homing signal for the recovery forces. As presently planned, this secondary system will consist of the real-time telemetry transmitter radiating a 2.5-watt unmodulated signal through the UHF Descent antenna. The frequency will be 230.3961 mc with the unmodulated carrier being transmitted through the Descent antenna beginning at main parachute deployment and continuing until spacecraft recovery or for 36 hours.

c. Flashing Recovery Light

A high-intensity xenon discharge lamp is provided to facilitate visual detection of the spacecraft during recovery operations. The light is a self-contained, self-extending system which is activated at the time of main parachute release. It is powered by a 6.75-vdc stack of Mercury cells and is electrically independent of all other spacecraft systems. The power supply consists of a dc to dc converter, a voltage doubler, a capacitive

network, and a trigger network. This system provides high-intensity xenon discharge flashes at a rate of 15 to 20 flashes per minute for a period of 12 hours after activation.

d. Fluorescein Dye Marker

The dye marker is located in the reentry module in a perforated container which is covered with water soluble film. Upon water immersion, the film dissolves and the dye is slowly dispensed to provide a yellow-green marking in the water downstream from the spacecraft.

e. Flotation Collar

The Gemini flotation collar (Reference 4) consists of a rubberized fabric tube formed in the shape of a horseshoe and fitted with a webbing sling. The tube is form-fitted around the spacecraft by swimmers after spacecraft landing, and when inflated with CO₂ is approximately 19 inches in diameter. The collar is installed during recovery operations to stabilize the spacecraft, permit safe entry and exit, and to provide an extended flotation capability in the event of water leakage into the spacecraft.

III. ANALYSIS OF THE HSQ RECOVERY PROBLEM

A. GENERAL INFORMATION

The extent of the field support required for the recovery of a large floating spacecraft from the surface of the open ocean area largely depends upon two main factors. These are (1) the geographic location and the size of the planned recovery area, and (2) the need for rapid access to, or retrieval of, the spacecraft soon after water landing due to the nature of the flotation system and/or the nature of the spacecraft mission.

In the case of the HSQ recovery, the best available information (References 5 and 6) indicates the recovery area will be near Ascension Island and of a relatively small size (50 by 200 nautical mile rectangle).

Consideration of the Gemini design (dependence upon water-tight integrity after impact for positive buoyancy) and the established NASA practice of insuring flotation by installing an auxiliary flotation collar after landing, indicates the need for rapid access to the HSQ spacecraft at the earliest practical time after landing. The unmanned nature of the HSQ mission, however, relaxes the need for rapid retrieval of the spacecraft or its crew.

In summary, the recovery forces will be deployed in the vicinity of Ascension Island, from which considerable support may be drawn. These forces will be staged into a relatively small 50 by 200 nautical mile recovery area and must be capable of rapidly locating the spacecraft and providing on-the-scene personnel to install an auxiliary flotation device, after which retrieval of the spacecraft may be pursued at a more leisurely pace.

Since the actual aiming point for the HSQ trajectory has not been established at this time, the proposed aiming point shown in Figure 1 has been selected to permit exercise of the search and retrieval problem in the planned recovery area.

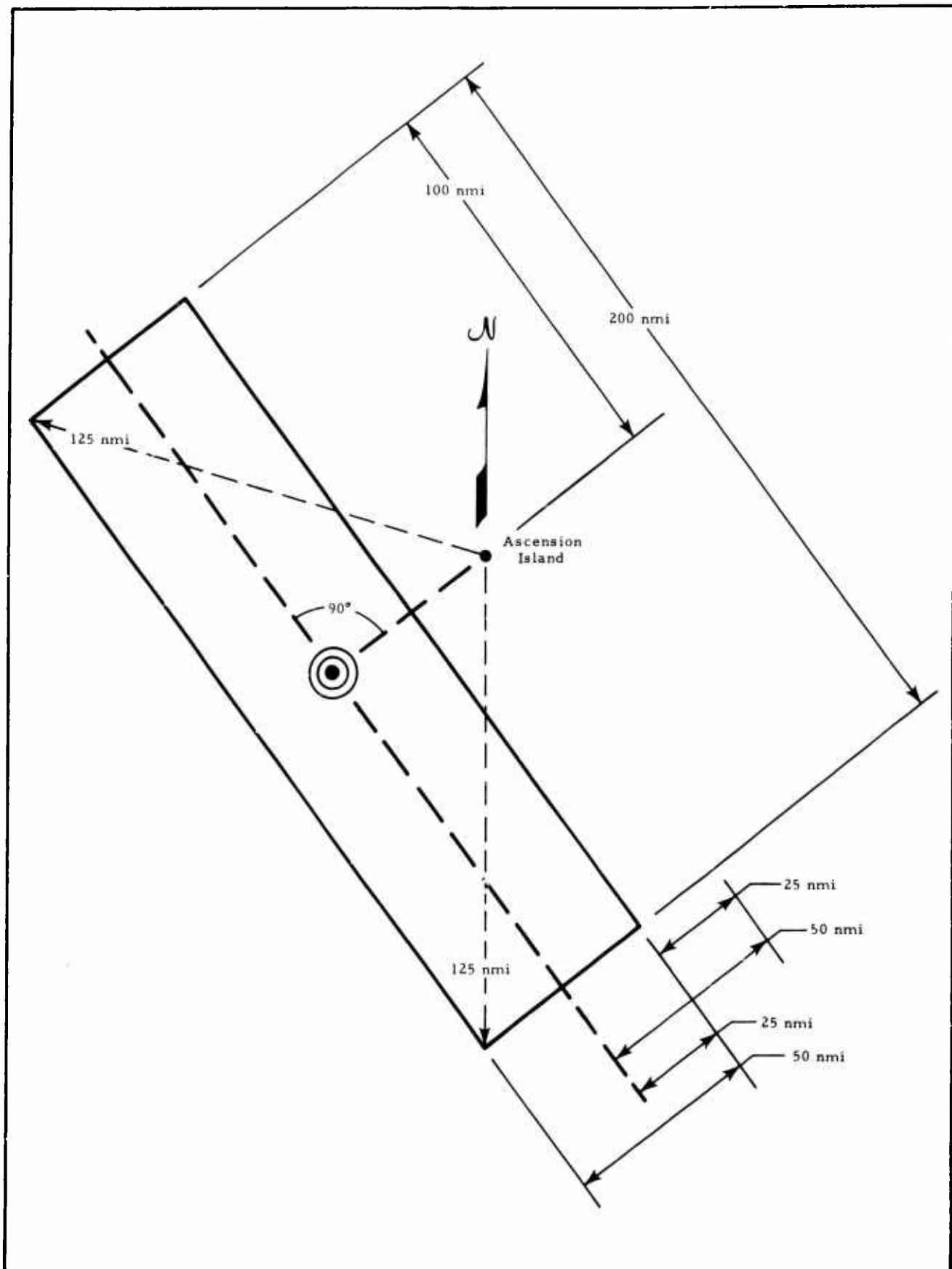


Figure 1. Planned Recovery Area

B. GEOGRAPHICAL LOCATION AND SIZE OF THE HSQ PLANNED RECOVERY AREA

The aiming point shown in Figure 1 was selected so as to locate the landing area favorably with respect to Ascension Island instrumentation coverage and to optimize the aircraft staging problem with respect to the Ascension Island airstrip. Appendix A describes the AFETR Ascension Island facilities and instrumentation pertinent to the HSQ recovery operation.

As shown in Figure 1, the selected aiming point is located 50-nautical miles southwest of Ascension Island, leaving a 25-nautical mile safety corridor between the Island and the eastern edge of the planned recovery area. The most remote points in the recovery corridor, with respect to the Ascension Island airstrip are the NW. and SW. corners of the corridor which are located at a straight line distance of 125 nautical miles from the airstrip. These maximum distances place the entire planned recovery area well within the search capabilities of the AFETR JC-130A Aircraft, the USAF ARS HC-130H Aircraft and the ARS HH-3C Helicopter with direct staging from Ascension Island.

C. RANGE SAFETY

Discussion of the HSQ impact area range safety problem with AFETR Range Safety (Reference 7) indicates that the following will be required prior to Range Safety approval of the HSQ impact area:

1. A nominal trajectory preferably with instantaneous impact point (IIP) data. This will be required to obtain instrumentation performance commitments and to identify all endangered areas.
2. The turning capability of the velocity vector when the IIP is near Ascension Island. This would be used to compute the standoff distance of the impact point based on instrumentation capabilities, data handling and computer delay times, and the Range Safety Officer's (RSO) reaction time.

3. The number, size, weight, drag, and impact point of jettisoned pieces commencing with the second stage for a normal reentry. If any pieces are expected to fragment on a normal reentry the same data will be required for the fragments.
4. The quantity, size, weight, drag, and impact points as a result of destruct action [which results in impacts] near Ascension Island.
5. The types of malfunctions that could endanger the island and their probability of occurrence. This probability of occurrence should include the probability of arriving at the point where the malfunction began. That is, the probability of success of each stage, etc., up to the time that the island could be endangered. If no value is provided Range Safety, they will assume a value of one for the probability of success up to the point the malfunction began.
6. The three-sigma dispersions of the jettisoned or fragmented pieces for items 3 and 4 above due to winds and missile performance. [i. e., The dispersions of the jettisoned or fragmented pieces about the 3- σ trajectories.]

Range Safety will conduct the impact and kill probability studies required for both Ascension Island and the recovery forces. Range Safety will require a statement of justification explaining why the recovery area needs to be close to Ascension Island. And finally, unless adequate justification is provided, they will limit the risk to each ship and to the island to 1×10^{-5} .

D. WAVE CLIMATOLOGY

Sea state distributions for the planned recovery area were analyzed to determine the percentage of time when sea conditions can be expected to exceed the Gemini spacecraft "safe recovery limit" of Code 4. The data analyzed were obtained from 10,293 ship observations reported to the National Weather Data Center and summarized by K. Nagler, et al, at the Space Flight Meteorology Group of the U. S. Weather Bureau.

These data were summarized to produce the quarterly sea state distribution curves shown in Figures 2A through 2D. As shown by the curves, sea conditions in the planned recovery area can be expected to exceed the Code 4 condition most frequently during the third quarter of the year when waves exceeding 8 feet in height were reported 7.0 percent of the time. Since this value was lower than expected, it is suspected that the data were influenced by an absence of shipping (and therefore ship observations) during periods of rough weather. In this regard, Reference 8, "A Special Study of Wave Data in the Ascension Island Area" prepared by the U.S. Navy Hydrographic Office in September 1957 was also obtained and analyzed. This study (refer to Appendix B) presents theoretical wave data for each quarter of the year based on observed wind velocities in the wave generating areas. As shown in Appendix B the theoretically derived data indicate that wave heights greater than 8 feet can be expected approximately 9, 17, 19, and 11 percent of the time, respectively, during the 1st through the 4th quarter of the year.

The preceding data indicate that prohibitive sea conditions may exist as much as 20 percent of the time in the planned recovery area, and although this is not considered a significant constraint, it indicates that careful attention must be given to preflight weather and sea state forecasts prior to final scheduling of the flight test.

E. RECOVERY FORCE DEPLOYMENT

In view of the foregoing, it appears reasonable to plan search and retrieval operations based on fixed-wing aircraft search, fixed-wing or helicopter deployment of personnel to install auxiliary flotation devices, and ship or helicopter operation to recover pararescue personnel and to retrieve the HSQ spacecraft.

1. SEARCH OPERATIONS

Figure 3 depicts a typical deployment of four C-130 Aircraft; two AFETR JC-130A Aircraft for terminal telemetry and postlanding search, and two ARS HC-130H Aircraft for postlanding search and deployment of

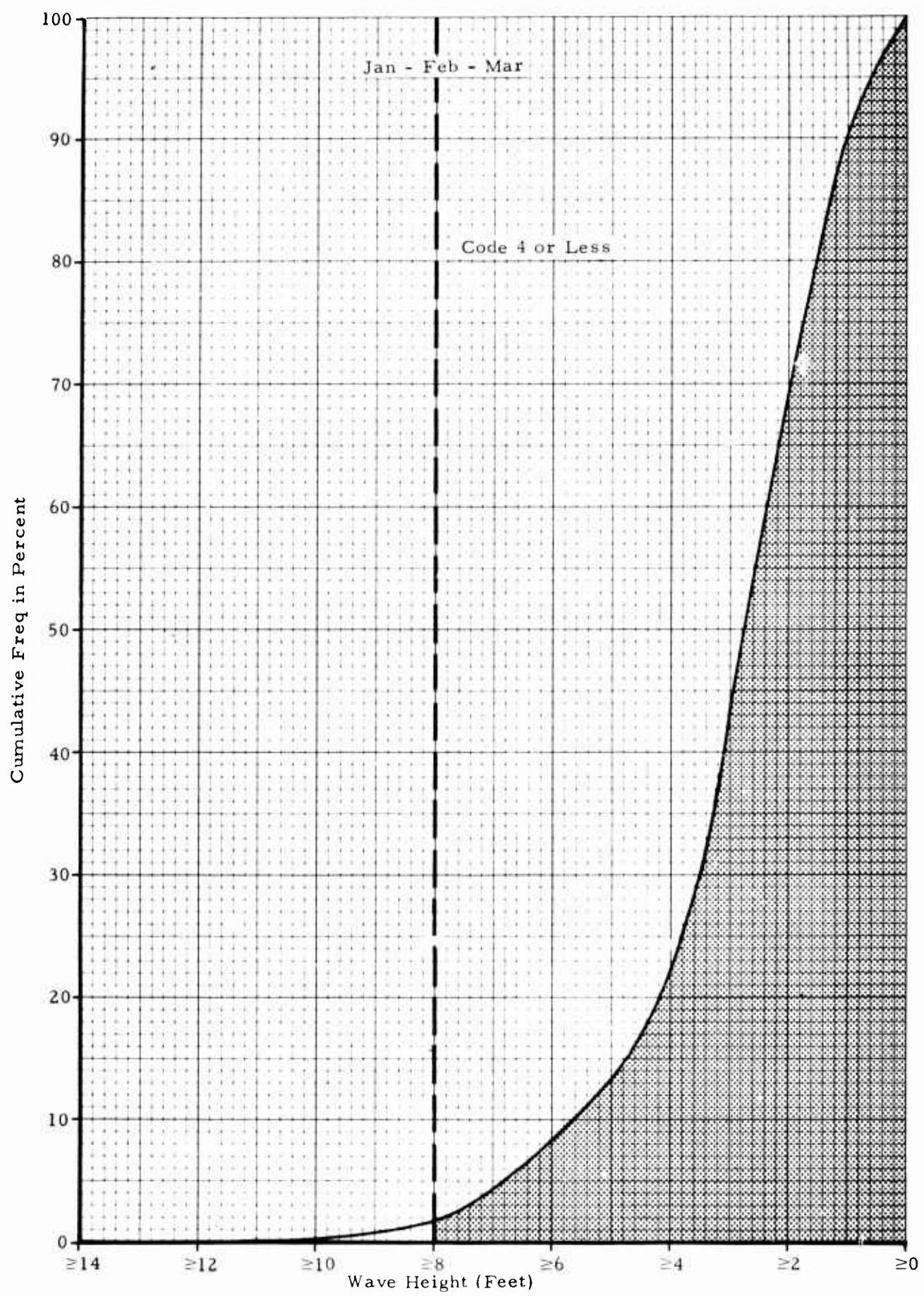


Figure 2A. Ascension Island Sea State Distribution

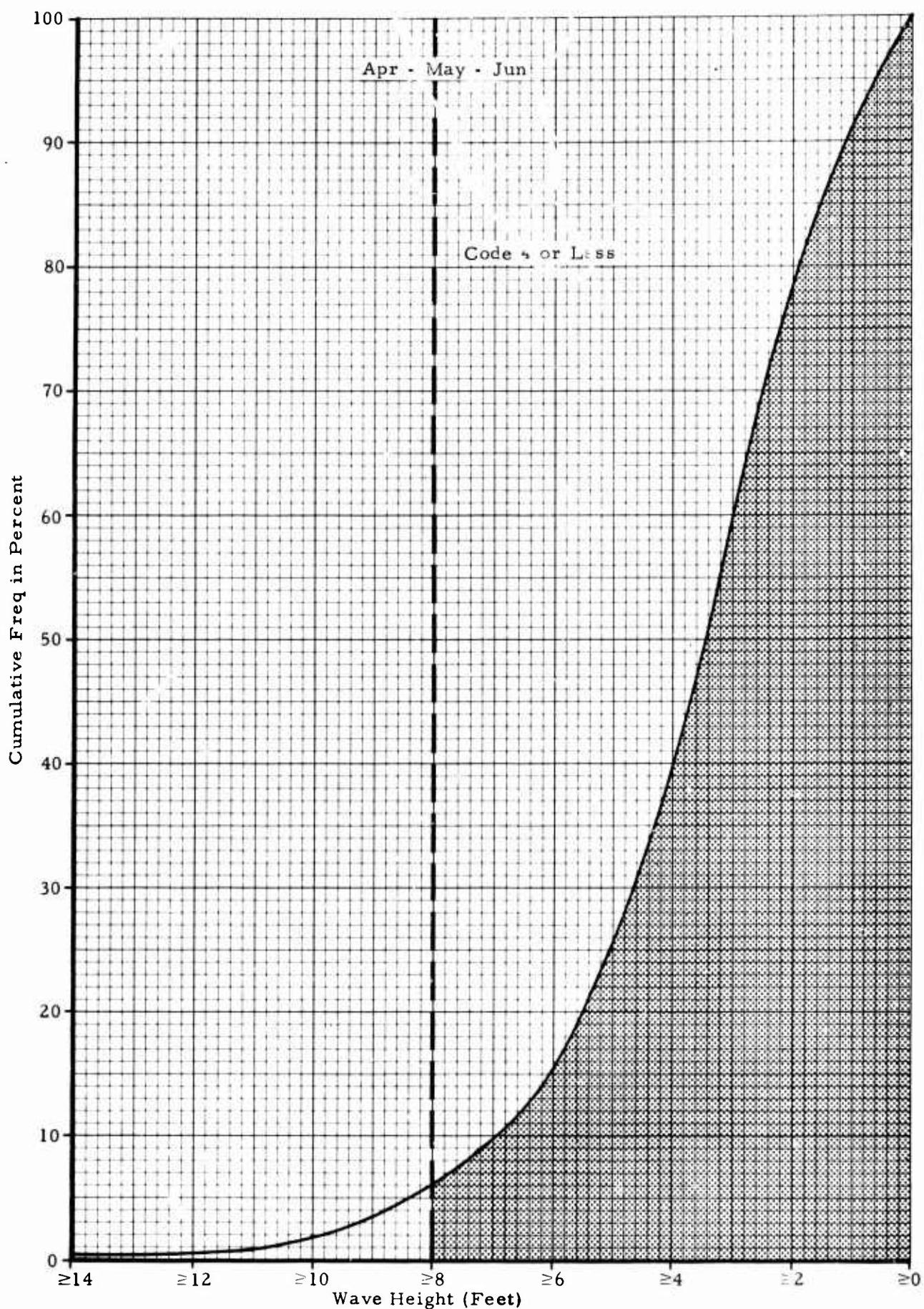


Figure 2B. Ascension Island Sea State Distribution - Continued

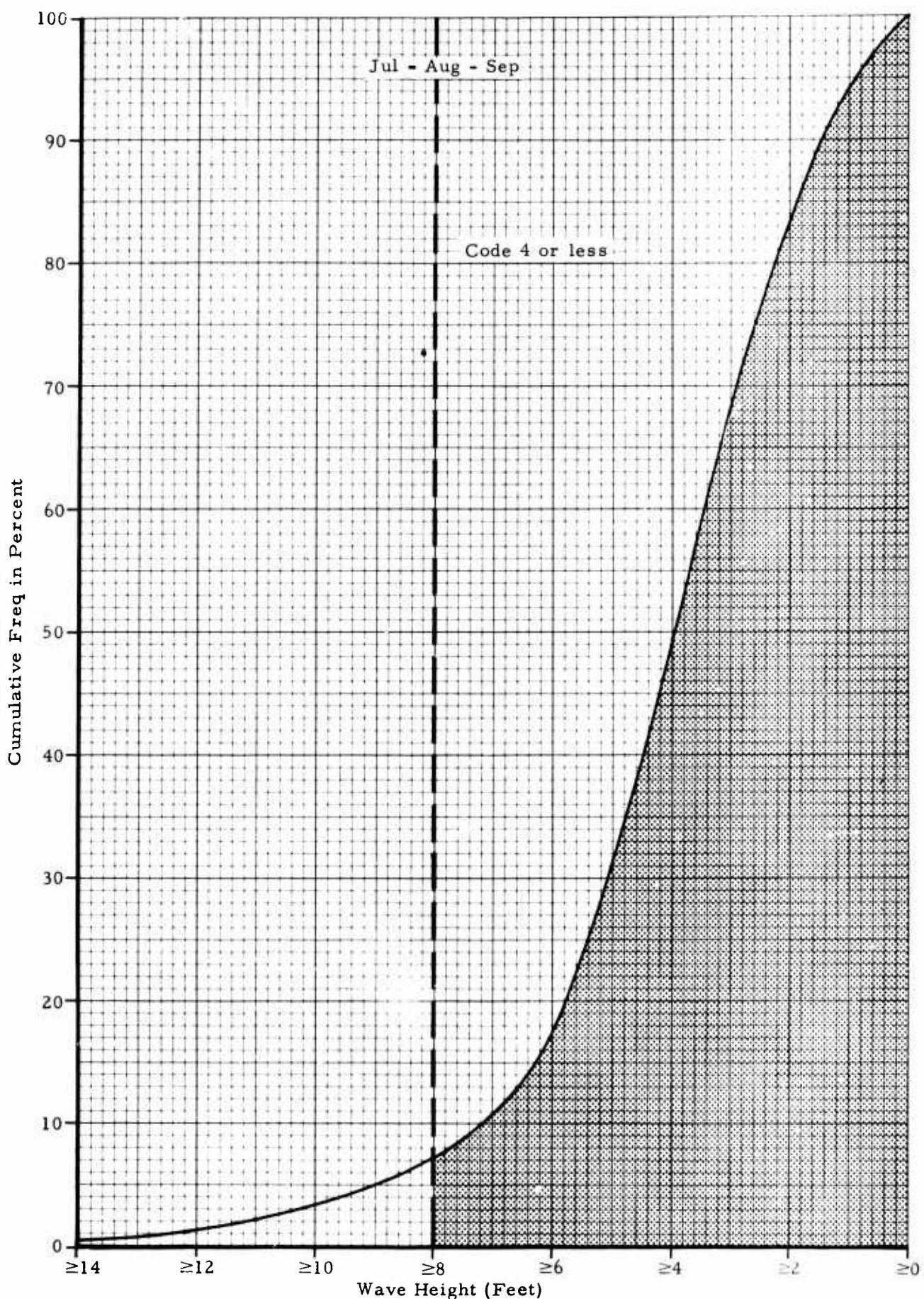


Figure 2C. Ascension Island Sea State Distribution - Continued

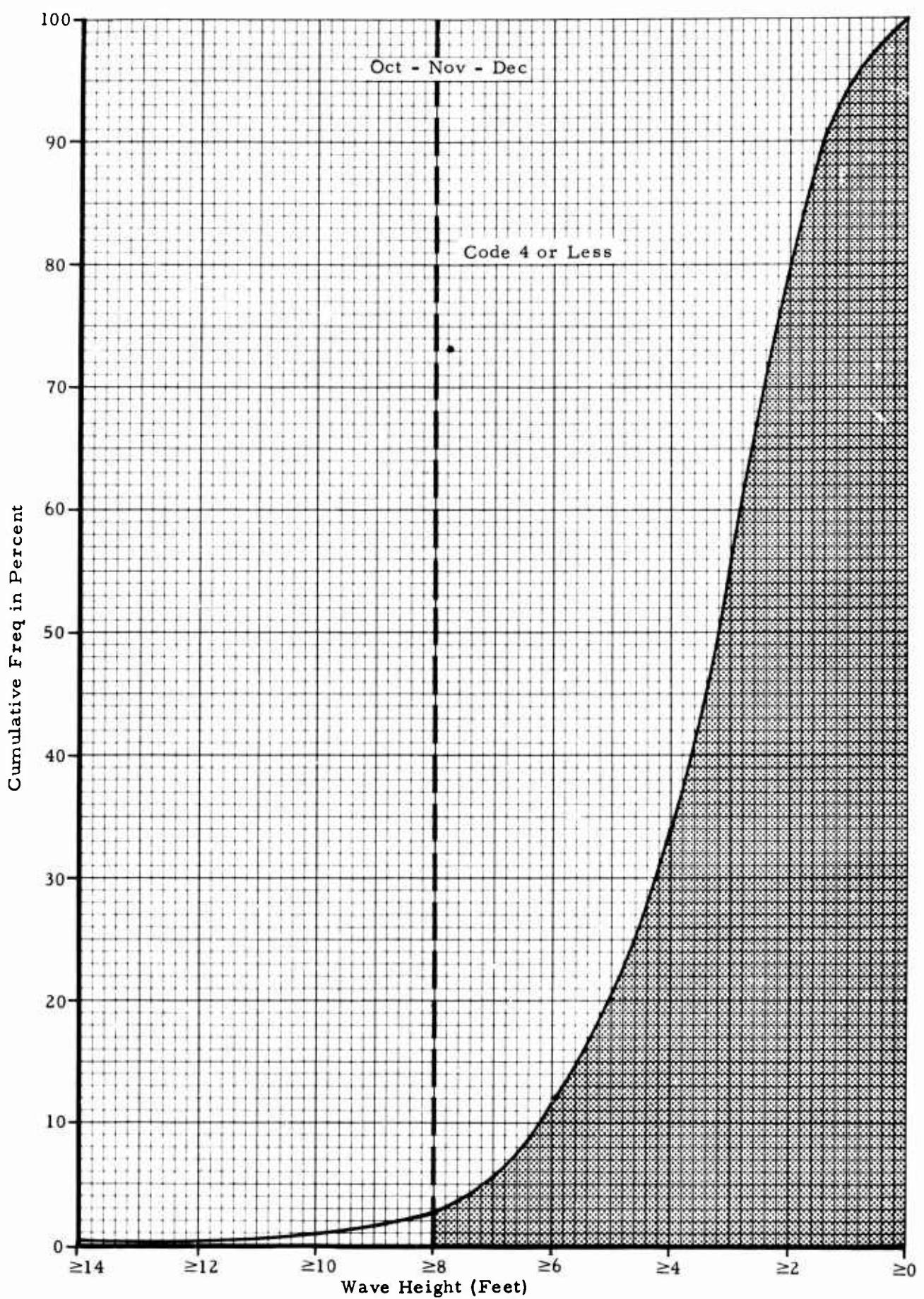


Figure 2D. Ascension Island Sea State Distribution - Continued

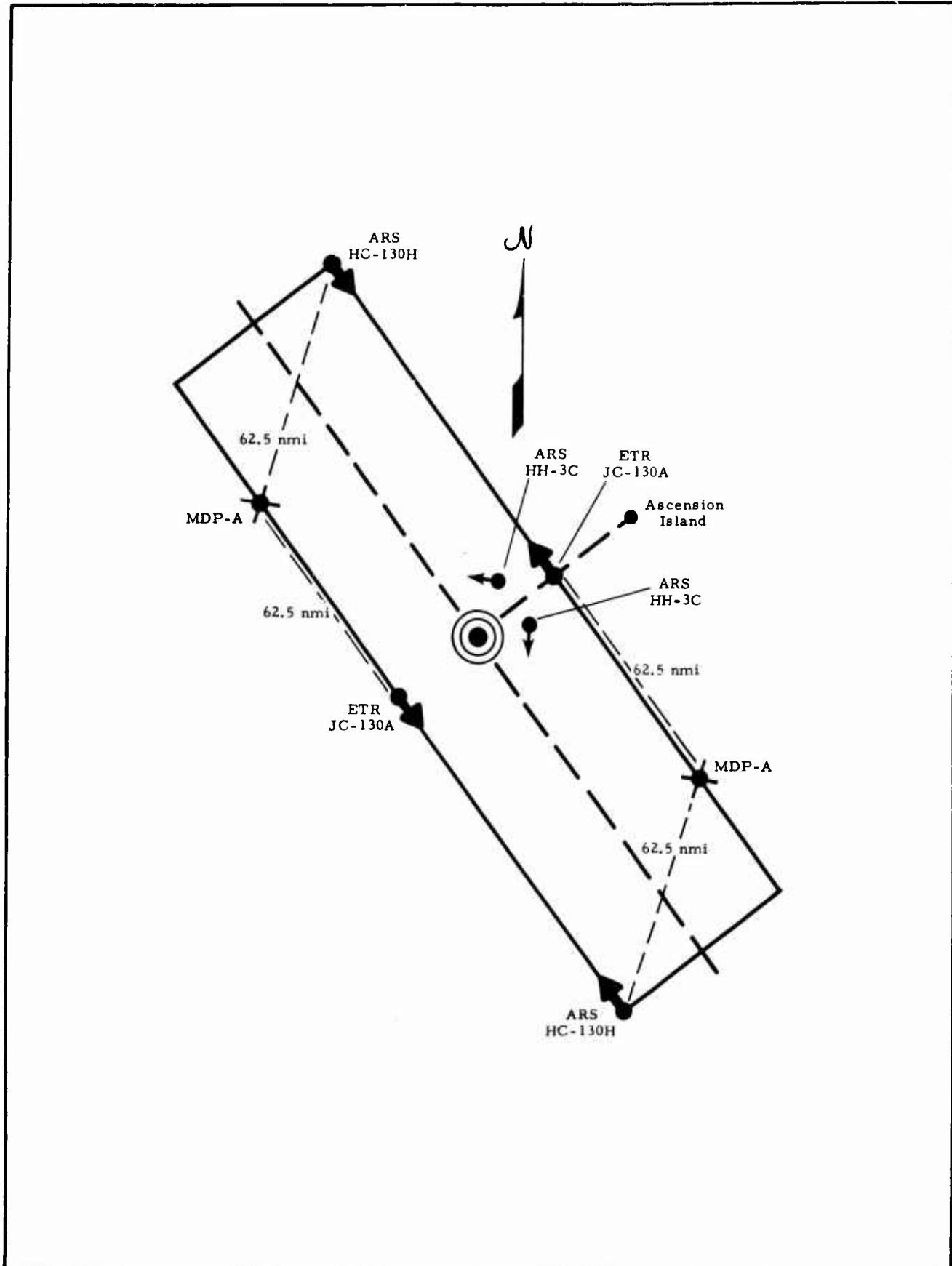


Figure 3. Search Aircraft Deployment

pararescue teams to ensure rapid installation of the Gemini flotation collar. The two HH-3C Helicopters supplement the fixed-wing search capability, provide additional swimmers for rapid deployment near the center of the planned recovery area, and provide a platform from which photographic coverage of the recovery operation may be obtained.

With this deployment of fixed-wing aircraft at the time of spacecraft landing, no point within the planned recovery area is more than 62.5 nautical miles from either of two search aircraft. The most-distant-point for the selected search aircraft deployment is indicated in Figure 3 as MDP-A. Since this point is well within the radio line-of-sight from the commonly employed C-130 Aircraft search altitudes, and within the established detection range for the HSQ electronic recovery aids, it follows that locating the HSQ spacecraft at any point within the planned recovery area may be accomplished in the time required for the C-130 Aircraft to "home" over a maximum distance of 62.5 nautical miles. Subsequent deployment of pararescue teams with appropriate support equipment may then be accomplished in the time required for visual location of the spacecraft and for aircraft descent from search altitude to suitable pararescue deployment altitude. In view of the foregoing it appears reasonable that a pararescue team would be in position to install the HSQ Gemini flotation collar not later than 60 minutes after spacecraft landing at any point within the planned recovery area. Under more favorable conditions, with the spacecraft landing closer to the nominal aiming point, this 60-minute lapse time could be substantially reduced with direct deployment of swimmers from either of the two HH-3C Helicopters.

2. RETRIEVAL OPERATIONS

a. Ship Retrieval

Investigation of the Range Instrumentation Ships (RIS) programmed for operation on the AFETR during FY 67 indicates the following vessels will be operational during the forecast HSQ time period:

	<u>Ship</u>	<u>Hull Type</u>	<u>Max Speed (knots)</u>
1.	TAGM-10 (Vandenburg)	C-4-S-A1	17
2.	TAGM-11 (Twin Falls Victory)	VC-2	17
3.	TAGM-12 (American Mariner)	EC-2	8
4.	TAGM-13 (Sword Knct)	C1-M-AVI	10
5.	TAGM-16 (Coastal Crusader)	C1-M-AVI	10
6.	TAGM-19 (modified tanker)	T2	17

Analysis of the spacecraft retrieval operation indicates that one ship stationed at the nominal aiming point would be capable of reaching the spacecraft at any point within the planned recovery area by steaming a maximum distance of 113 nautical miles. If the selection of a ship for the mission was limited to the TAGM-10, 11, and 19 with flank speeds of 17 knots, this maximum distance could be traversed (at a nominal speed of 15 knots) in approximately 7-1/2 hours, under the wind and sea conditions which might be expected during a planned recovery mission. Figure 4 shows the steaming times required throughout the planned recovery area for one ship with a nominal speed of 15 knots. Figure 5 shows the nominal steaming times which might be expected if two C1-M-AVI type vessels with a nominal speed of 9 knots were deployed to the indicated positions.

b. Helicopter Retrieval

If helicopter retrieval of the HSQ spacecraft is utilized, deployment of the HH-3C Helicopters from the positions shown in Figure 3 to the most distant point in the planned recovery area may be accomplished in less than 1 hour with subsequent pickup and delivery of the HSQ spacecraft to either a Range Instrumentation Ship or directly to Ascension Island within 3 hours after spacecraft landing.

3. SUMMARY

In summary, the recovery force deployment outlined above, consisting of four C-130 Aircraft, two HH-3C Helicopters and one Range Instrumentation Ship with a 15 knot nominal speed, is capable of locating the spacecraft and installing a flotation collar within a maximum time of 1 hour after spacecraft

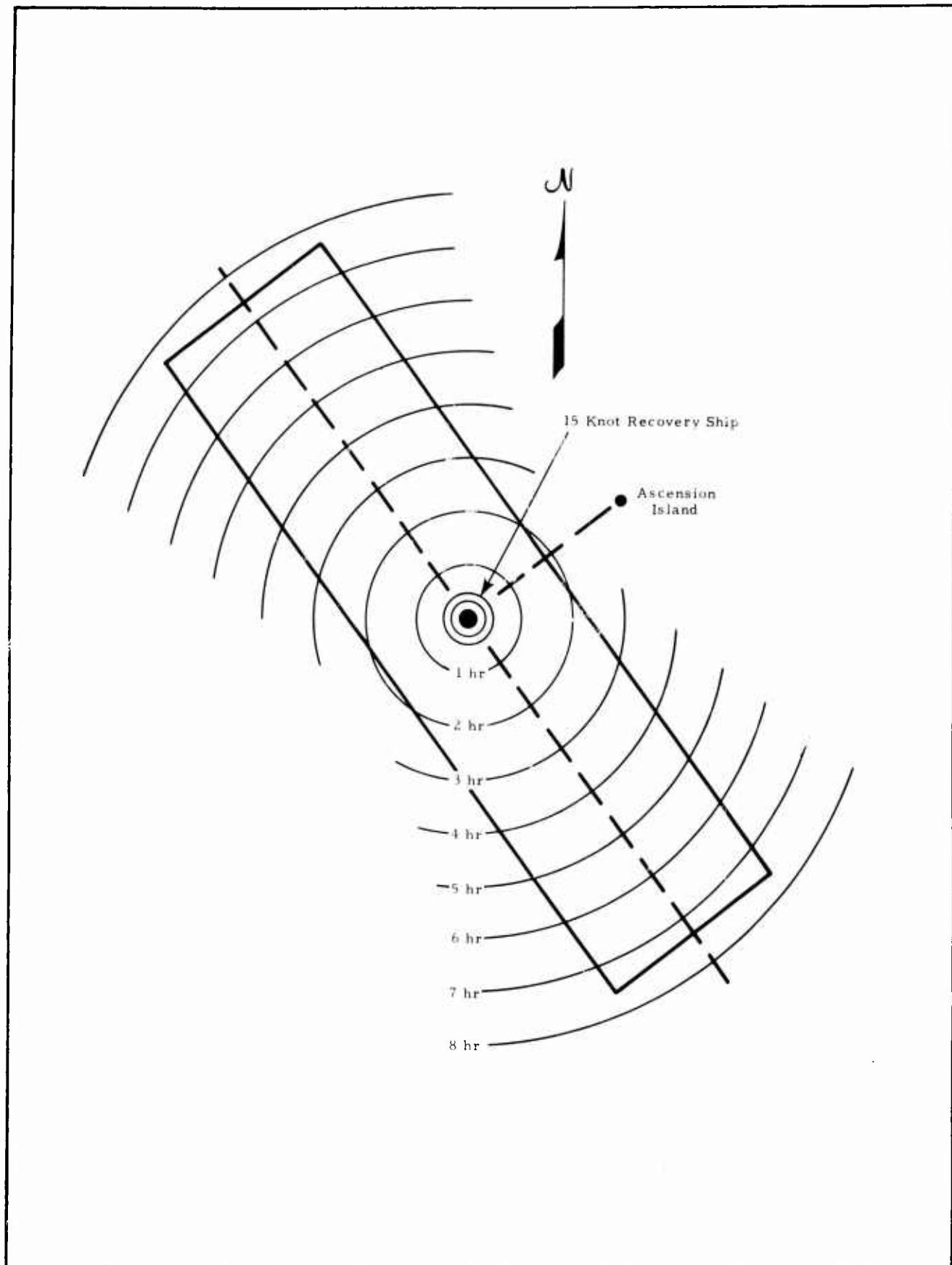


Figure 4. One Ship Retrieval Time (15 Knot Recovery Ship)

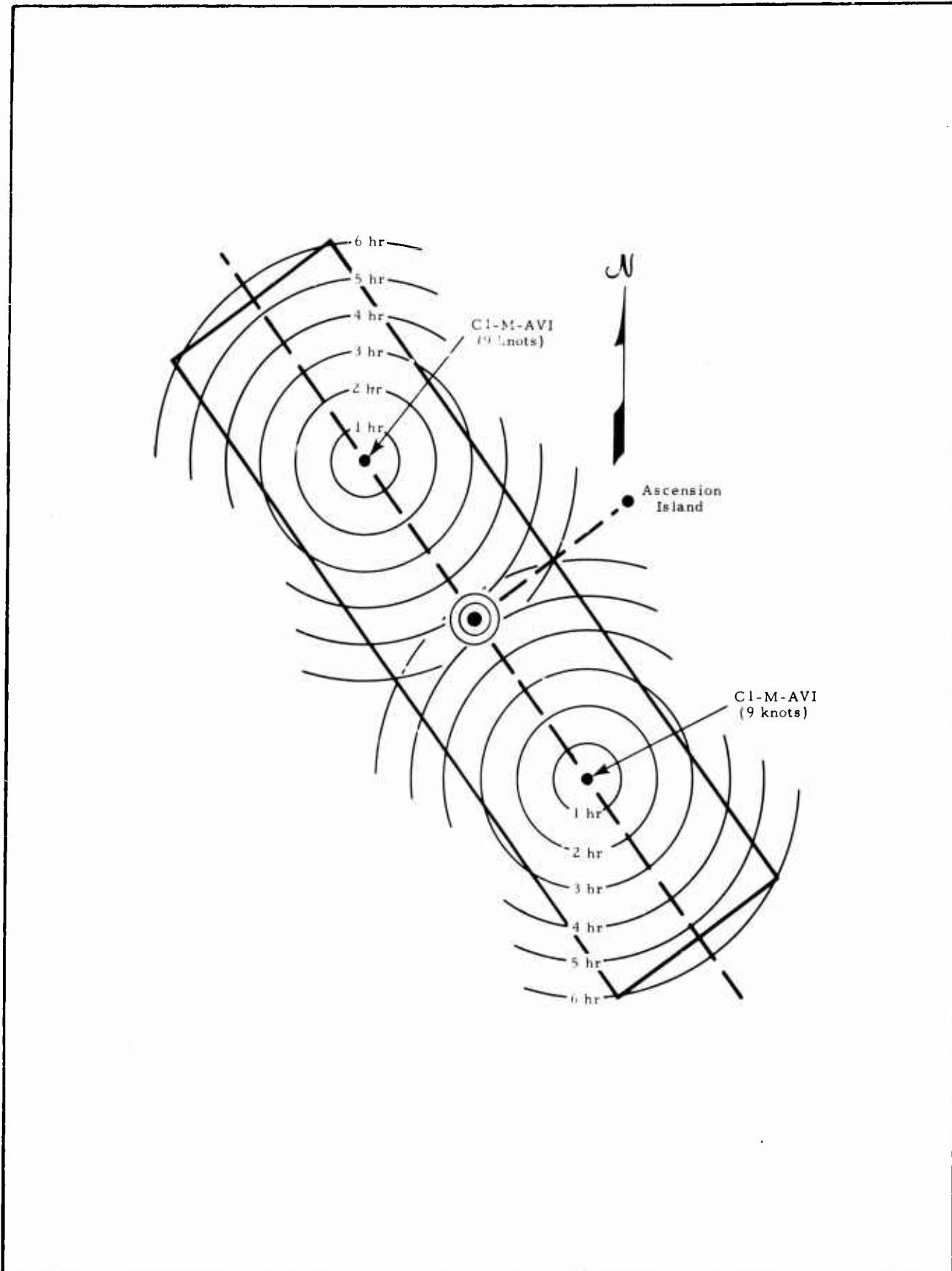


Figure 5. Two Ship (C1) Retrieval Time

landing and subsequently retrieving the spacecraft by surface ship within a maximum of 8 hours and by helicopter within a maximum of 3 hours after spacecraft landing.

F. HH-3C HELICOPTER DEMONSTRATION

Since helicopter retrieval of the MOL Gemini B and/or its crew is being considered as a primary recovery technique, it appears desirable to use the HSQ mission as a means to establish and demonstrate the required helicopter techniques. No disadvantage is seen in this so long as adequate backup (surface ship retrieval capability) is provided as previously outlined. It therefore appears desirable to assign the primary HSQ retrieval effort to the ARS HH-3C Helicopters with a secondary, backup responsibility assigned to the AFETR Range Instrumentation Ship.

Before a decision to assign spacecraft retrieval responsibility to the HH-3C can be made, however, a demonstration of the helicopter ability to lift and transport the HSQ spacecraft long distances over water is imperative. At this writing, two unsuccessful attempts (Reference 9) to lift a Gemini boilerplate with the HH-3C have been made. Detailed investigation of these tests revealed problems with the lifting hardware being used. The major problem stems from the single point lifting loop normally provided on the Gemini spacecraft for hoisting the spacecraft aboard ship. Use of this single point attachment during helicopter lift and transport causes uncontrolled rotation of the spacecraft beneath the helicopter.

Needed improvements include redesign of the HH-3C cargo hook/spaceship sling interface; design and development of a two point attachment sling compatible with the Gemini two-point bridle disconnect fittings; and design and development of suitable cradles, dollies, or other devices for releasing the spacecraft on a ship's deck or other suitable landing area. When lifting hardware problems have been solved, considerable work will be required to develop suitable guidelines for management of the helicopter fuel/gross weight budget. At this time, the HH-3C has no provision for fuel dumping prior to spacecraft pickup. Under certain recovery area

deployment conditions, this could require the HH-3C to hover over the spacecraft for several hours to burn off sufficient fuel so that pickup could be accomplished within the HH-3C gross weight limitations. Satisfactory solution of this problem may require modifications to the HH-3C fuel system to provide a fuel dump capability or jettisonable external fuel pods.

None of the problems outlined above are considered prohibitive to the HSQ recovery mission; however, it should be emphasized that considerable work is necessary before a reliable HH-3C/HSQ retrieval technique can be demonstrated.

G. SEARCH AND RECOVERY TRAINING

Since the techniques, equipment, and personnel which will be used for the HSQ recovery will differ from those used during previous Gemini recovery operations, considerable training will be required. Experience with similar AFETR recovery programs has indicated an advantage to separating recovery training exercises into two categories; an early training effort wherein ship and aircraft procedures are developed, standardized, and documented; and a later "dress rehearsal" training exercise using deployed equipment and embarked personnel in situ a few days prior to the actual recovery operation.

The early training effort could logically be combined with the HH-3C Helicopter demonstration discussed previously. These exercises should be staged in any suitable uprange AFETR area convenient to Patrick AFB and should be planned so that during the final helicopter demonstration, a realistic recovery situation is presented. During the final uprange exercise, a dummy, or boilerplate Gemini spacecraft should be placed at a suitable location within a planned recovery area. Search aircraft should then be required to demonstrate homing to the spacecraft and deployment of pararescue teams, helicopter retrieval should be demonstrated, and the spacecraft should be delivered to a Range Instrumentation Ship to demonstrate the prescribed ship handling techniques.

The dress rehearsal exercise should be staged in the actual planned recovery area on F-3 day as a mandatory prerequisite to the HSQ Flight Test operation. This effort should exercise all essential search and recovery procedures, equipment, and personnel; as well as required communication links, and the Command and Management structure.

IV. HSQ RECOVERY AGE

A. DISCUSSION

This section describes the major, long leadtime items of recovery support equipment required for the HSQ recovery operation which can be identified at this time. Additional requirements for minor items and some major items will materialize as the early training exercises are executed. In anticipation of these short leadtime requirements, provisions should be made in the HSQ spacecraft contract for contractor response to recovery AGE requirements generated within the AFETR Recovery Working Group as a result of experience gained during early recovery training exercises.

The recovery support AGE can be divided into three major categories, namely, that required for training, retrieval, and postrecovery handling.

B. TRAINING EQUIPMENT

1. HSQ GEMINI BOILERPLATE

The two types of training exercises and the helicopter demonstrations discussed in the previous section will require the use of a realistic dummy spacecraft or boilerplates, capable of simulating the flotation and pickup dynamics of the HSQ spacecraft. These boilerplates should be designed for compatibility with the standard Gemini flotation collar and should have provisions for the installation of a UHF Recovery Beacon. Design of the beacon installation should be such that the boilerplate can be used with or without the beacon installed. The boilerplate should also realistically simulate the wet and dry weight and center of gravity characteristics of the HSQ spacecraft; i. e., water ballasting during flotation and water dumping during retrieval pickup.

2. UHF RECOVERY BEACON SIMULATOR

The beacon simulators provided for use with the boilerplates during training exercises should duplicate the power and signal characteristics of the actual Gemini UHF Recovery Beacon (refer to Section II, paragraph

C. 4. a.). This device should be powered by a replaceable battery power supply of sufficient size to permit continuous beacon operation for a period of 12 hours.

3. QUANTITY OF TRAINING AGE

In view of the training exercises previously described, it is recommended that two boilerplate spacecraft be provided, one for shipboard training and one for uprange helicopter training. Three UHF Recovery Beacon Simulators and six battery power supplies are considered necessary; one for each boilerplate and one spare system, each with a spare power supply.*

C. RETRIEVAL EQUIPMENT

	Type	Quantity
1)	HH-3C two point lifting slings	4
2)	Ship cargo boom lifting slings	3
3)	HH-3C Spacecraft Cradle	4
4)	Range Instrumentation Ship Spacecraft Cradle	4
5)	Gemini Flotation Collar (two for each aircraft and six for training)	18

D. POSTRECOVERY HANDLING EQUIPMENT

	Type	Quantity
1)	Spacecraft transportation dolly	3
2)	Spacecraft deactivation & analysis kit	3
3)	Downrange hypergolic environmental health kit	3

*This training equipment may also be used for later MOL/Gemini B training exercises.

APPENDIX A

ASCENSION ISLAND CAPABILITIES

Recovery of the HSQ Gemini spacecraft in the Ascension Island area permits use of the AFETR Facilities at Station 12 for staging aircraft and ships, providing logistic and communication support to recovery forces, and tracking the spacecraft during terminal trajectory. The pertinent AFETR capabilities and facilities programmed for Station 12 during the FY 67 time period are as outlined below.

GENERAL INFORMATION

Station 12, on the southwestern portion of Ascension Island, is located at 7° 58' South latitude, 14° 24' West longitude. Following is a summary of the facility and instrumentation capabilities of the station.

A. FACILITIES

1. SHIP HANDLING AND DOCKING

Ships anchor offshore — 40-ton mobile crane on the pier is used to unload. Heavy loads are transported to shore via LST.

2. STATION PERSONNEL

630 (includes TDY)

3. TRANSIENT PERSONNEL CAPABILITY

200

4. PRESENT RUNWAY LENGTH

10,000 ft with 1,000-ft overrun (This includes recent extension.)

5. AIRCRAFT HANDLING CAPABILITY

a. Number of hangars — 0

b. Maintenance facilities — capable of changing engine — carry some spare parts.

c. Types and quantity of fuel — 1,240,000 gallons JP-4, 360,000 gallons avgas, and 300,000 gallons diesel.

6. MATS SCHEDULED FLIGHTS AND ROUTES TAKEN

Three flights per week (leave Patrick AFB Monday, Wednesday, and Friday). Routes are as follows: Antigua — Zanderij — Recife — Ascension. C-130 used for freight and C-118 for passengers.

7. MSTS OR OTHER ROUTINE SHIP SCHEDULES

Presently using Moore-McCormack lines with direct service from Port Canaveral to Ascension Island with a ship leaving every fourth week. However, if the need arises, by utilizing the Ferrell Lines and the Moore-McCormack lines with routes to northern U. S. and then Ascension, the capability is increased to one ship each week.

E STATION 12 INSTRUMENTATION

i. TELEMETRY

Equipment	Existing	Programmed
<u>Antennas</u>		
TLM-18 130-1000 mc	1	
TAA-3 225-2300 mc	1	
Log Periodic 130-2300 mc	1	
Tri-Helix 215-260 mc	1	
<u>Receive/Record System</u>		
TRKI-12 Diversity System	12 links	
<u>Data Separation</u>		
Fixed Discriminators	36	
Tunable Discriminators	10	
TDM Type I	2	
TDM Type II	1	
TDM Type III	1	

Equipment	Existing	Programmed
<u>Data Display</u>		
Oscillographs	40 channels	
Pen Recorders	32 channels	
Analog Bar Chart	40 channels	
Digital Bar Chart	40 channels	
<u>Data Processing</u>		
A-D Converters	48 channels	
D-A Converters	100 channels	
Real-Time Data System	1	
<u>Communications</u>		
Digital, HF to Antigua	3 at 2,400 BPS	
Analog, HF to Tel-4, CKAFS	1 at 48 kc	

2. COMMAND CONTROL

Equipment	Status Existing	Programmed
<u>Antenna</u>		
Steerable Quad-Helix (TEMEC)	1	
<u>RF Amplifier</u>		
240D-2	1	
<u>Exciter</u>		
AN/FRW-2A	1	
<u>Coder/Decoder</u>		
Tone	1	

3. METRIC TRACKING

Equipment	Existing	Programmed
AN/TPQ-18 Radar (C-Band) [*] (Figure A-1)	1	

4. DATA HANDLING

Equipment	Status Existing	Programmed
<u>Computer System 1206</u>		
Computer, Univac 1375 (Mod to 1376)	1	
Tape Unit, Computer, Univac 1246 (2-transports)	1	
Converter, Main Digital/ Analog MILGO, 1576C	1	
Converter, Digital, MILGO 1623-16A	1	
Converter, Synchro, MILGO 1623-4A	1	
Converter, Digital/TTY MILGO 165B	1	
Buffer, Raw Data, MILGO 1623-1A	1	
Buffer, Output, MILGO 1623-2A	1	
Tape Recorder, Raw Data, MILGO 1585	1	
Readout Display, Range, MILGO 1641-20	2	
Line Printer, Univac 250M	1	

*Figure A-1 shows the shadow pattern for the TPQ-18 radar at Station 12.

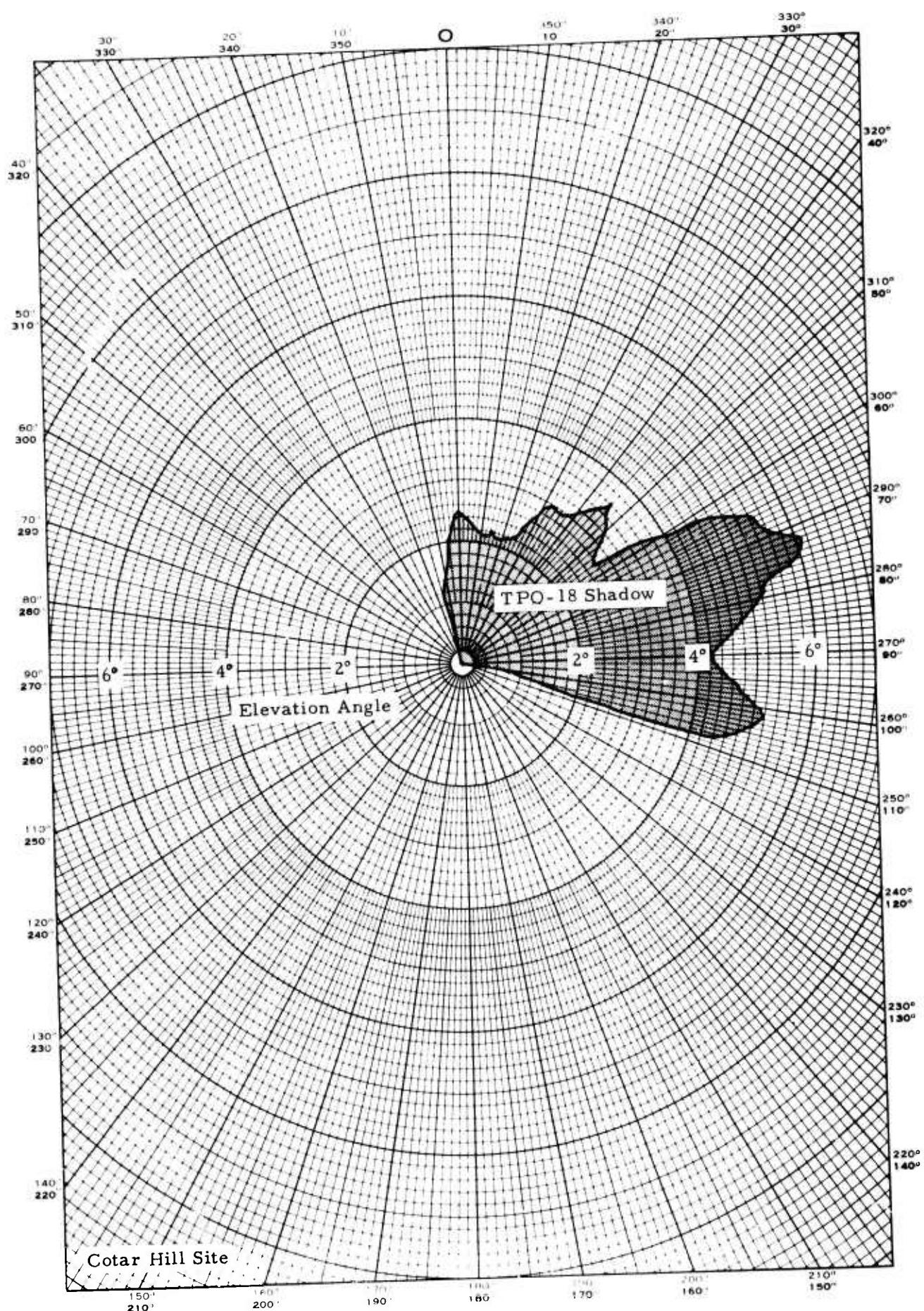


Figure A-1. Station 12-Ascension Island TPQ-18 Shadow Pattern

Equipment	Existing	Programmed
FPS-16 DH System		
Converter, Polar/Cartesian, EA 484A	1	
Converter, Cartesian/Polar EA 484B	1	
Plotter, XY, 205J-1	2	
Amplifier Rack, (20 amp) 4.028	2	
Glotrac DH System		
Station Acquisition Control <u>Console (DC Analog)</u>	1	
DC Amplifier		
Patch Board		
Range Rate Generator		
TLM-18 DH System		
Converter, Polar/Cartesian, 484A	1	
Converter, Cartesian/Polar, 484B	1	
TAA-3 DH System		
Potentiometers, Sin/Cos		1
Converter, Cartesian/Polar		1
Transmitter, Data, Digital		1
Receiver, Data, Digital		1
Synchro and Switching Equipment		1

5. TIMING

Equipment	Status Existing	Programmed
Receiver, WWV	1	
Receiver, Loran-C	1	
Receiver, VLF	1	
100-kc Frequency Standard-Master Clock	2	
IRIG Generator - Time Code	2	
UHF Distribution System	1	
Timing Receivers	As Rreqd	
Decoders	As Rreqd	
Timing Terminals Units	As Rreqd	

6. COMMUNICATIONS

Equipment	Existing	Programmed
<u>Transmitters</u>		
45 kw with 12 kc Exciter	11	1
45 kw with 6 kc Exciter	1	
10 kw with 12 kc Exciter	2	
10 kw with 6 kc Exciter	5	
2.5 kw with 6 kc Exciter	6	
2.5 kw AM 96D or FRT-15	2	
UHF G/A Medium Power System	1	
UHF T282/GR	4	
VHF 406A	4	
Ionospheric Pathsounder Transmitter	1	

Equipment	Existing	Programmed
<u>Transmitters (Continued)</u>		
VHF G/A Low Power Terminal		
Single Channel Receiver		2
Single Channel Transmitter		2
Multiple Channel Transceiver		1
<u>Receivers</u>		
Strip, 12 kc Diversity	9	
50E6D Diversity	8	
50E6	1	
R 390 12 kc Adapter	10	
R 390 CV 157	4	
51S1		5
VHF 51M2	4	
<u>Antennas</u>		
Rhombic	28	
Log Periodic (Rotatable)	10	
Log Periodic (Fixed)	4	
UHF Discone	4	
VHF RC 81C/GR	4	
Miscellaneous	20	

APPENDIX B
WAVE CLIMATOLOGY^{*}

Theoretical wave data are presented for each quarter of the year for the Ascension Island area. These data were derived theoretically from wind observations made in the generating areas.

A. WAVE HEIGHT BY DIRECTION

The seasonal data presented in Tables B-I through B-IV show the theoretical frequency by percentage of various wave heights with respect to the direction of wave travel.

B. WAVE PERIOD DISTRIBUTION

Figures B-1 through B-4 show the wave period theoretical distribution by cumulative frequency in percent for each quarter of the year.

C. WAVE HEIGHT AND PERIOD

Figures B-5 through B-8 present cumulative frequency curves showing the theoretical probability of surface waves equal to and exceeding any specified height and period combination. A point on a curve indicates the cumulative frequency of waves having periods and heights equal to and exceeding that at the selected point. The vertical distance between curves indicates the percent occurrence of waves equal to and greater than the figure on the height scale directly below the points in question.

The following example will illustrate use of the cumulative frequency curves:

The January, February, and March graph (Figure B-5) for the area shows that waves with periods of 7 seconds or more and heights of 5 feet

* Reference 8

or greater occur about 14 percent of the time. Waves with periods from 5 to 7 seconds and heights of 5 feet or more occur with a frequency of 8 percent.

TABLE B-I

Theoretical Computations of Wave Frequency (By Percentage), Direction, and Height in the Ascension Island Area for the First Quarter of the Year

DIRECTION	WAVE HEIGHT (FT.)			
	0 - 5	5 - 8	8 - 12	12 - 16
North	2.9	0.2	-	-
Northeast	0.4	-	0.1	-
East	7.1	1.3	0.2	-
Southeast	57.5	5.2	6.4	1.0
South	3.7	0.7	0.4	0.1
Southwest	5.2	1.2	0.5	0.2
West	-	-	-	-
Northwest	5.0	0.6	0.1	-
Total	81.8	9.2	7.7	1.3

Frequency (Percent)

TABLE B-II

Theoretical Computations of Wave Frequency (By Percentage), Direction, and Height in the Ascension Island Area for the Second Quarter of the Year

DIRECTION	WAVE HEIGHT (FT.)			
	0 - 5	5 - 8	8 - 12	12 - 16
North	3.8	0.4	0.1	-
Northeast	0.2	-	-	-
East	9.0	2.7	2.2	2.4
Southeast	40.9	6.4	7.0	2.1
South	5.0	1.4	0.5	2.0
Southwest	9.2	2.2	1.2	0.6
West	-	-	-	-
Northwest	0.6	0.1	-	-
Total	68.7	13.2	11.0	7.1

Frequency (Percent)

TABLE B-III

Theoretical Computations of Wave Frequency (By Percentage), Direction, and Height in the Ascension Island Area for the Third Quarter of the Year

DIRECTION	WAVE HEIGHT (FT.)			
	0 - 5	5 - 8	8 - 12	12 - 16
North	1.7	-	-	-
Northeast	0.4	-	-	-
East	6.7	3.6	1.6	0.2
Southeast	40.8	9.7	8.3	4.4
South	6.9	1.0	1.5	0.6
Southwest	8.1	2.4	1.3	0.7
West	-	-	-	-
Northwest	0.1	-	-	-
Total	64.7	16.7	12.7	5.9

Frequency (Percent)

TABLE B-IV

Theoretical Computations of Wave Frequency (By Percentage), Direction, and Height in the Ascension Island Area for the Fourth Quarter of the Year

DIRECTION	WAVE HEIGHT (FT.)			
	0 - 5	5 - 8	8 - 12	12 - 16
North	2.0	0.3	-	-
Northeast	0.1	-	-	-
East	6.5	4.5	1.6	0.6
Southeast	51.8	7.4	5.2	1.5
South	6.8	0.5	0.3	0.1
Southwest	5.7	1.5	1.2	0.4
West	0.1	-	-	-
Northwest	1.8	0.1	-	-
Total	74.8	14.3	8.3	2.6

Frequency (Percent)

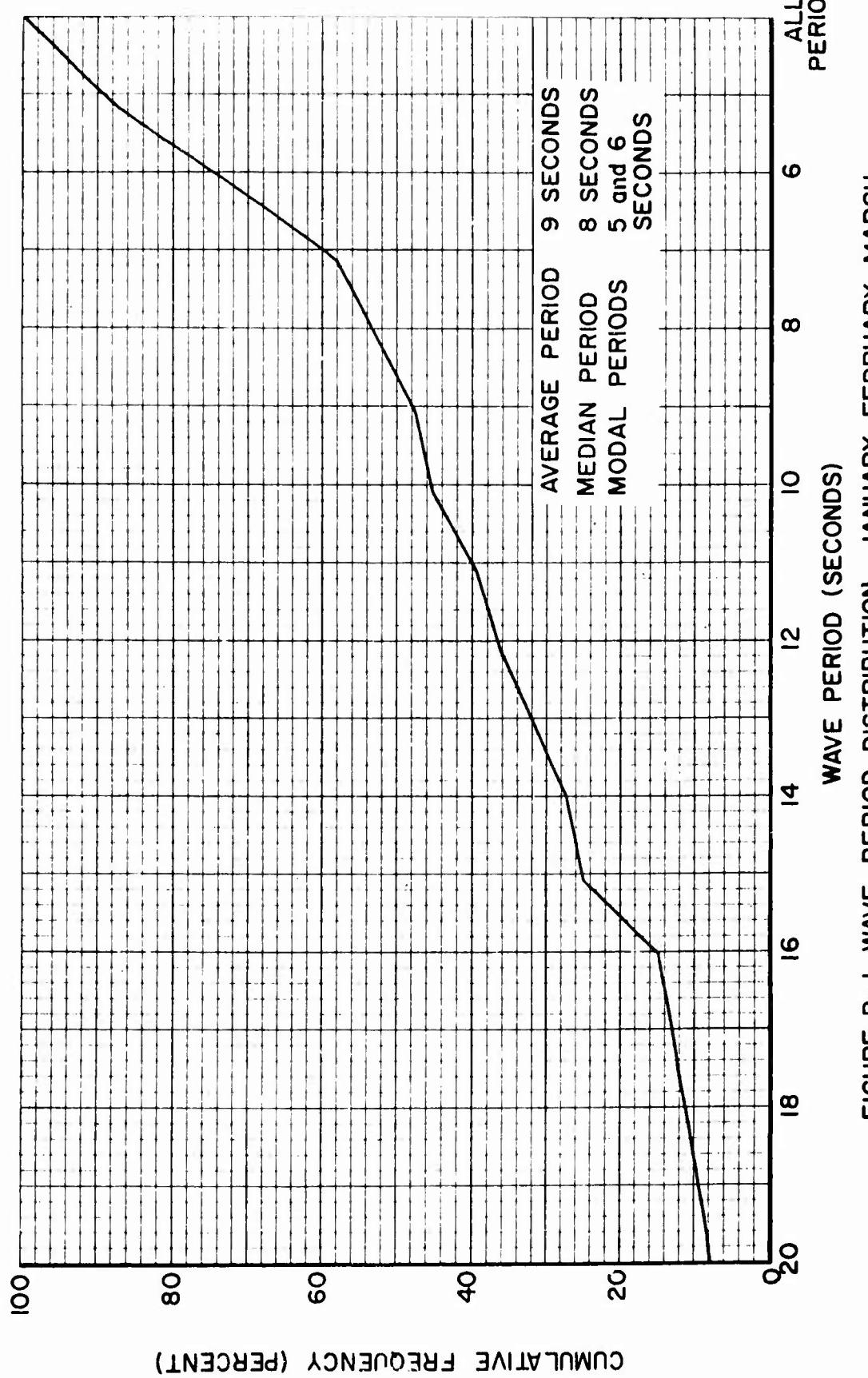


FIGURE B-1-WAVE PERIOD DISTRIBUTION - JANUARY-FEBRUARY-MARCH

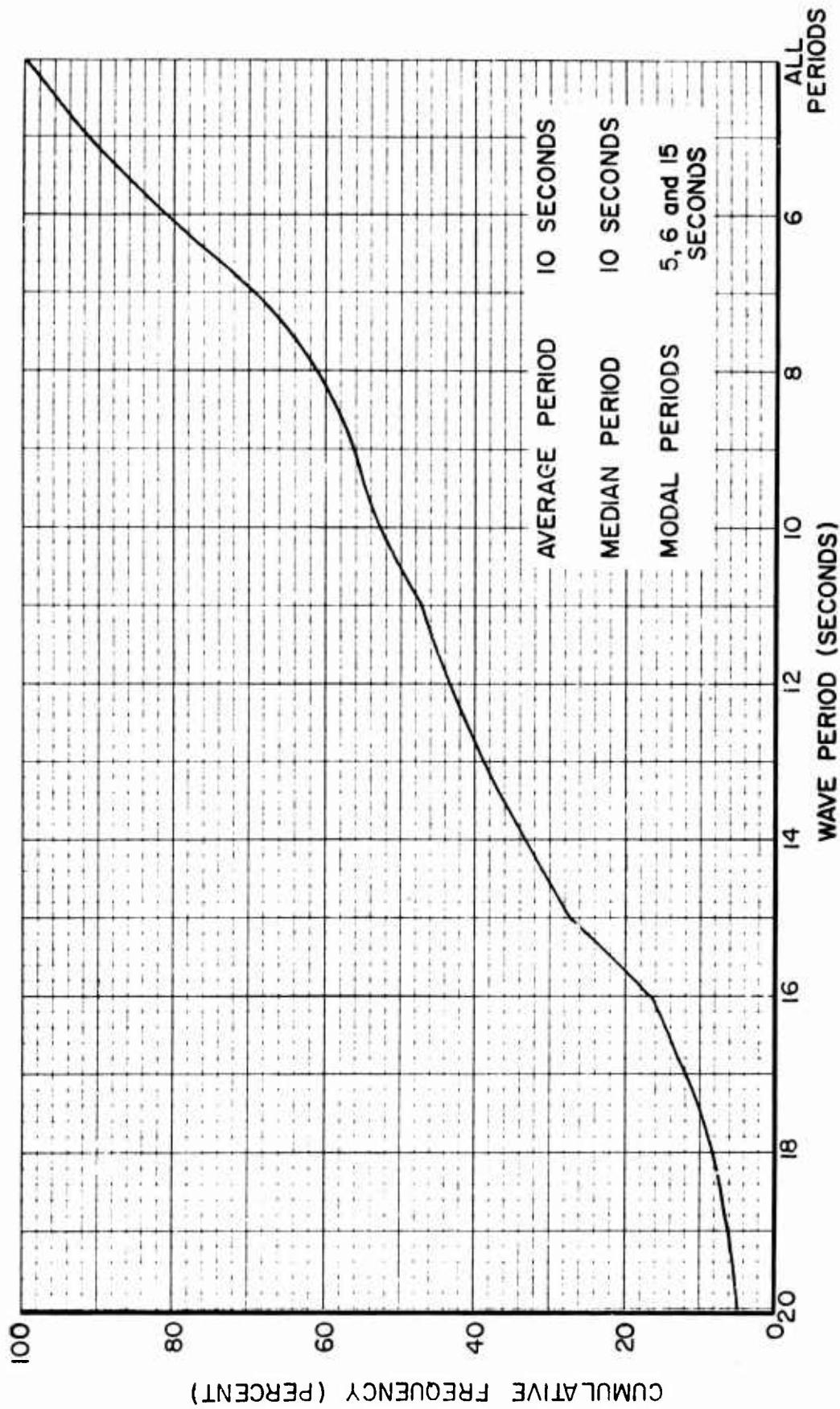


FIGURE B-2 - WAVE PERIOD DISTRIBUTION - APRIL - MAY - JUNE

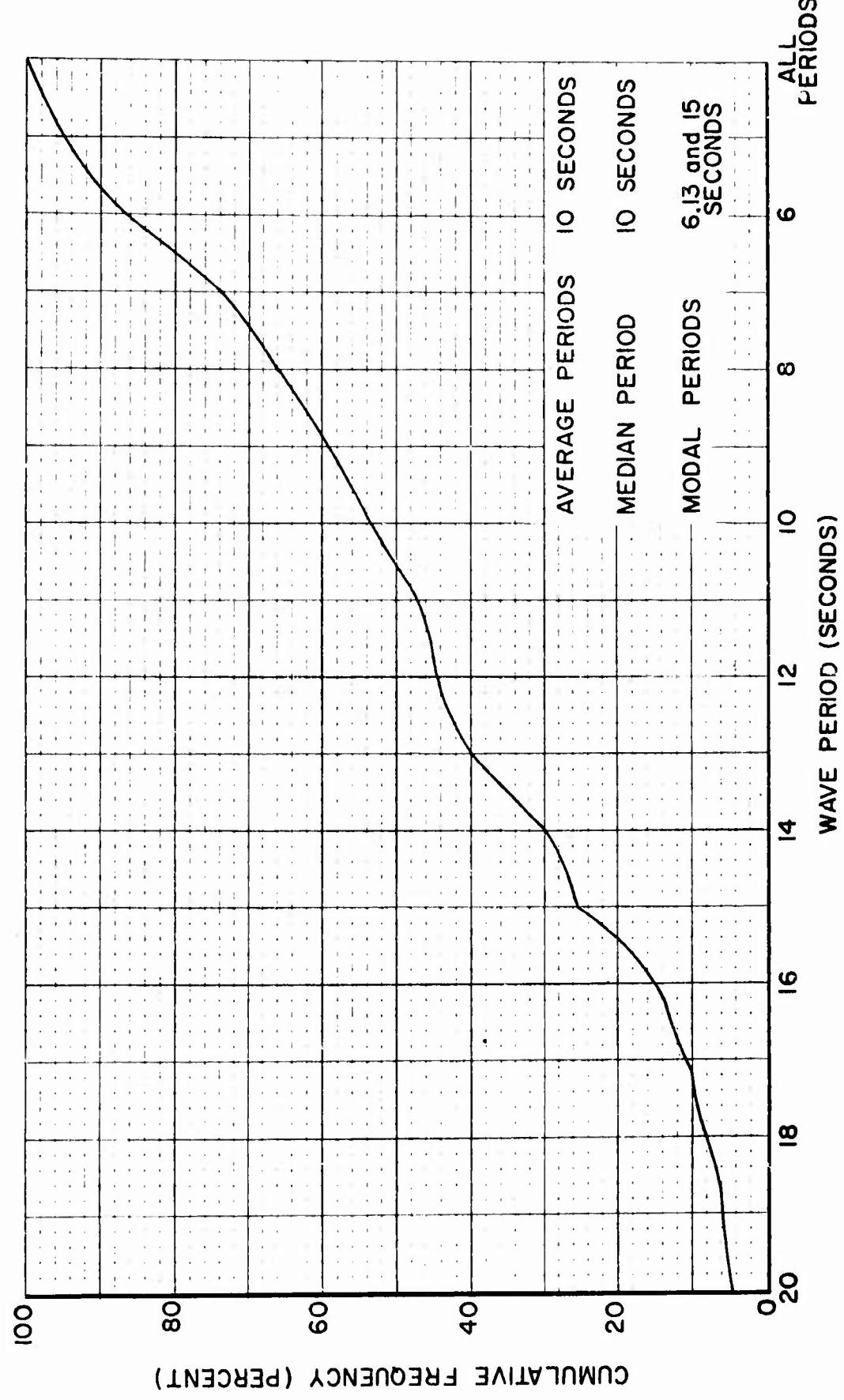


FIGURE B-3—WAVE PERIOD DISTRIBUTION — JULY-AUGUST—SEPTEMBER

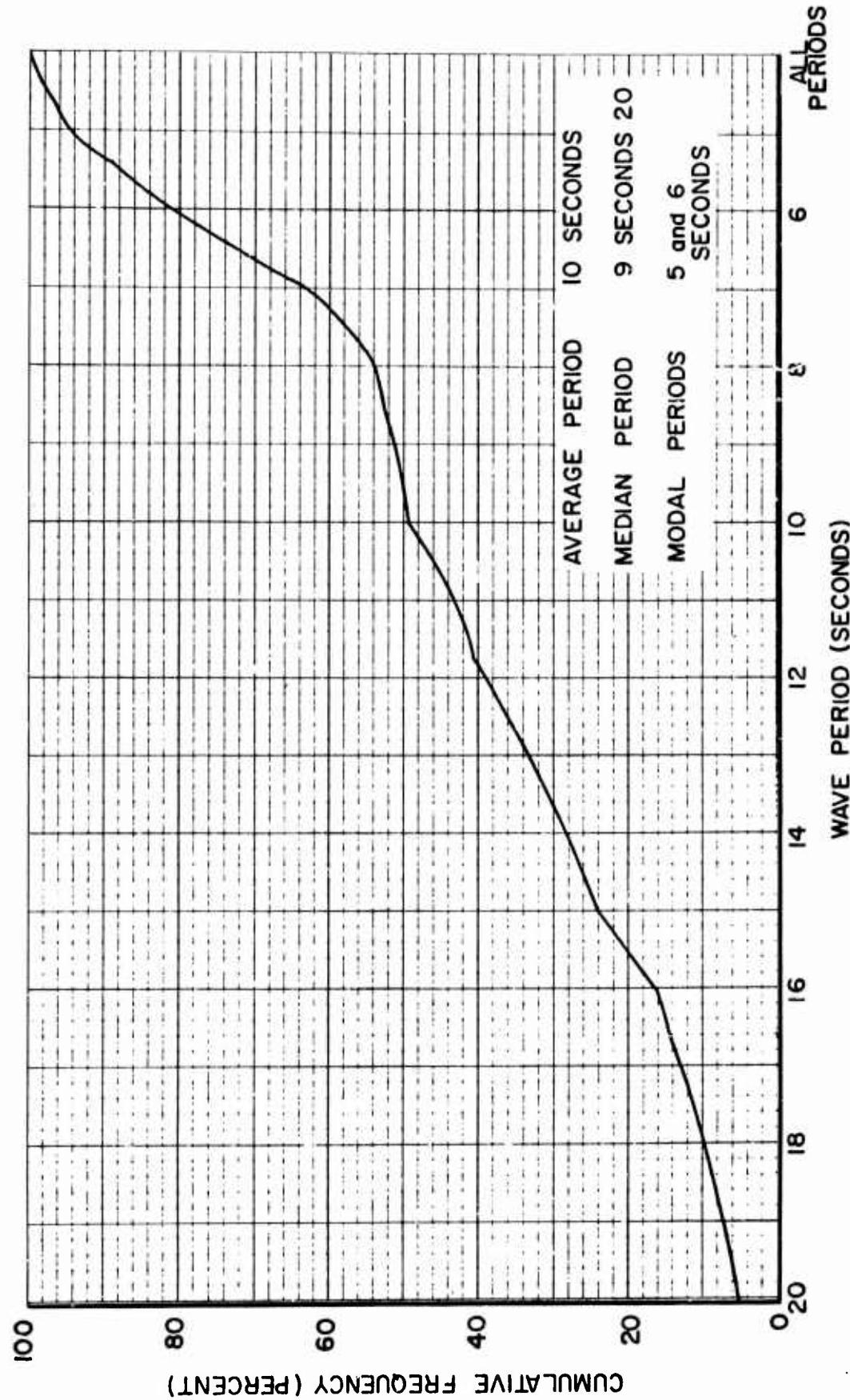


FIGURE B-4-WAVE PERIOD DISTRIBUTION - OCTOBER-NOVEMBER-DECEMBER

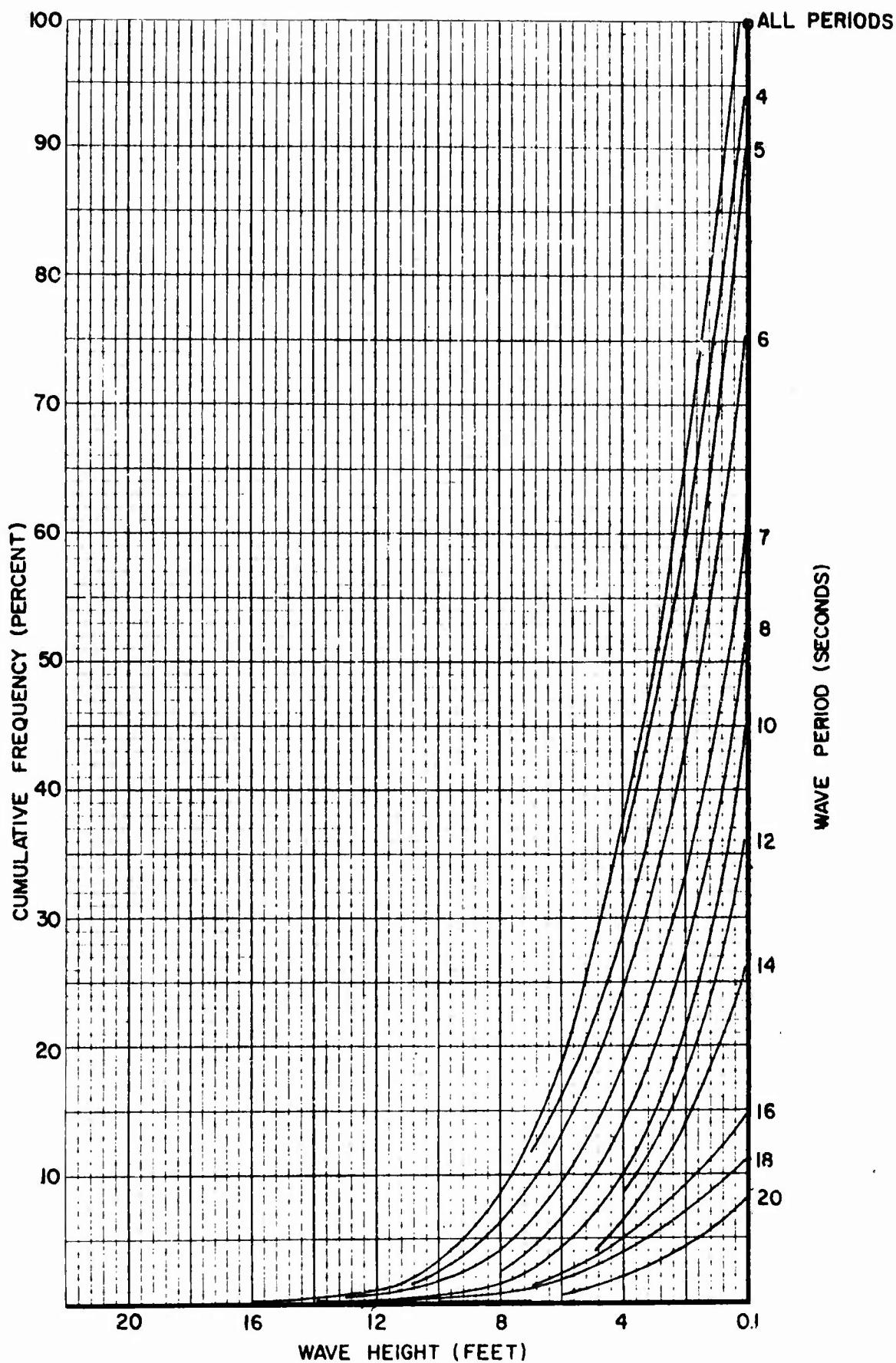


FIGURE B-5-WAVE HEIGHT VS WAVE PERIOD
JANUARY-FEBRUARY-MARCH

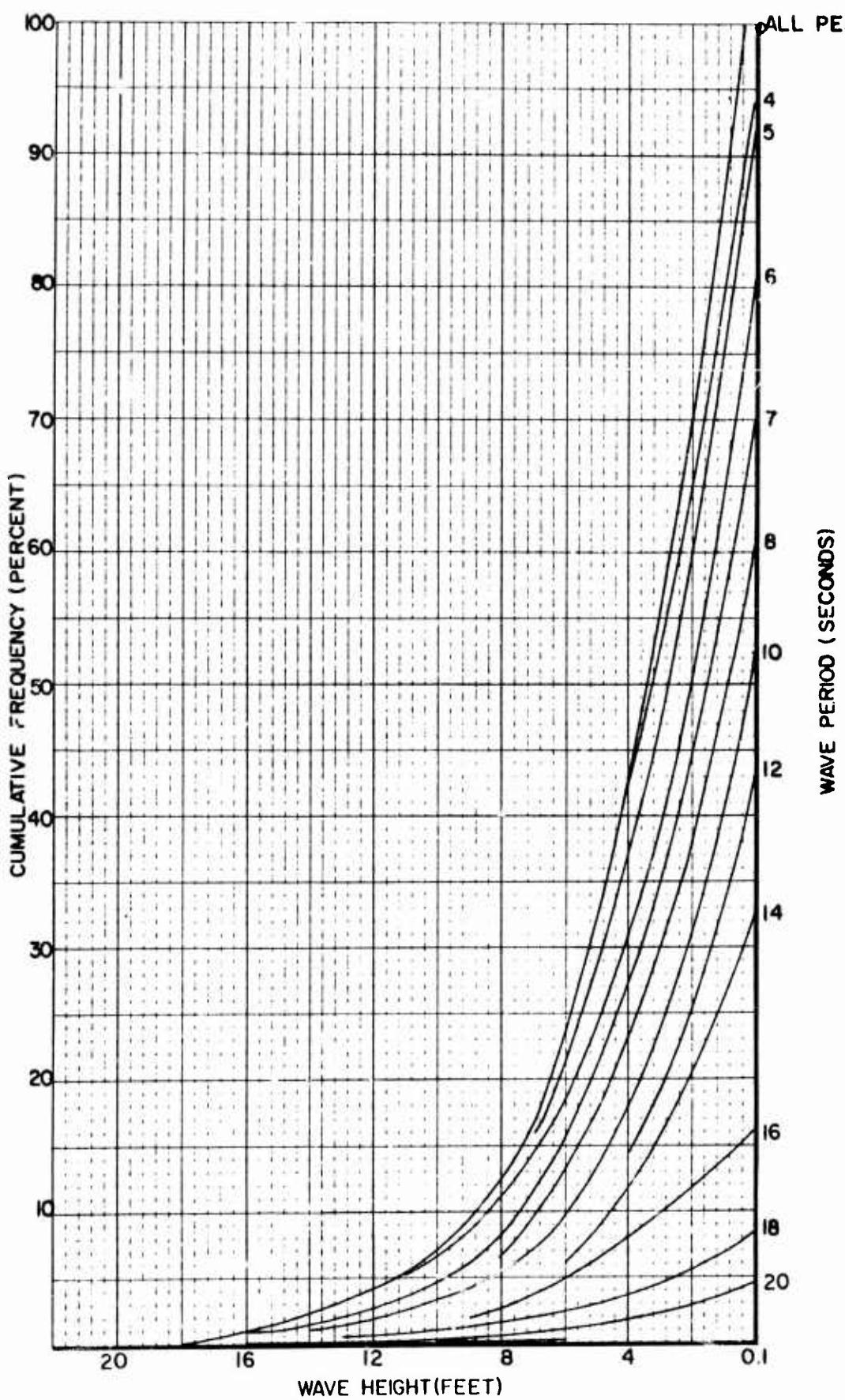


FIGURE B-6-WAVE HEIGHT VS WAVE PERIOD
APRIL - MAY - JUNE

B-12

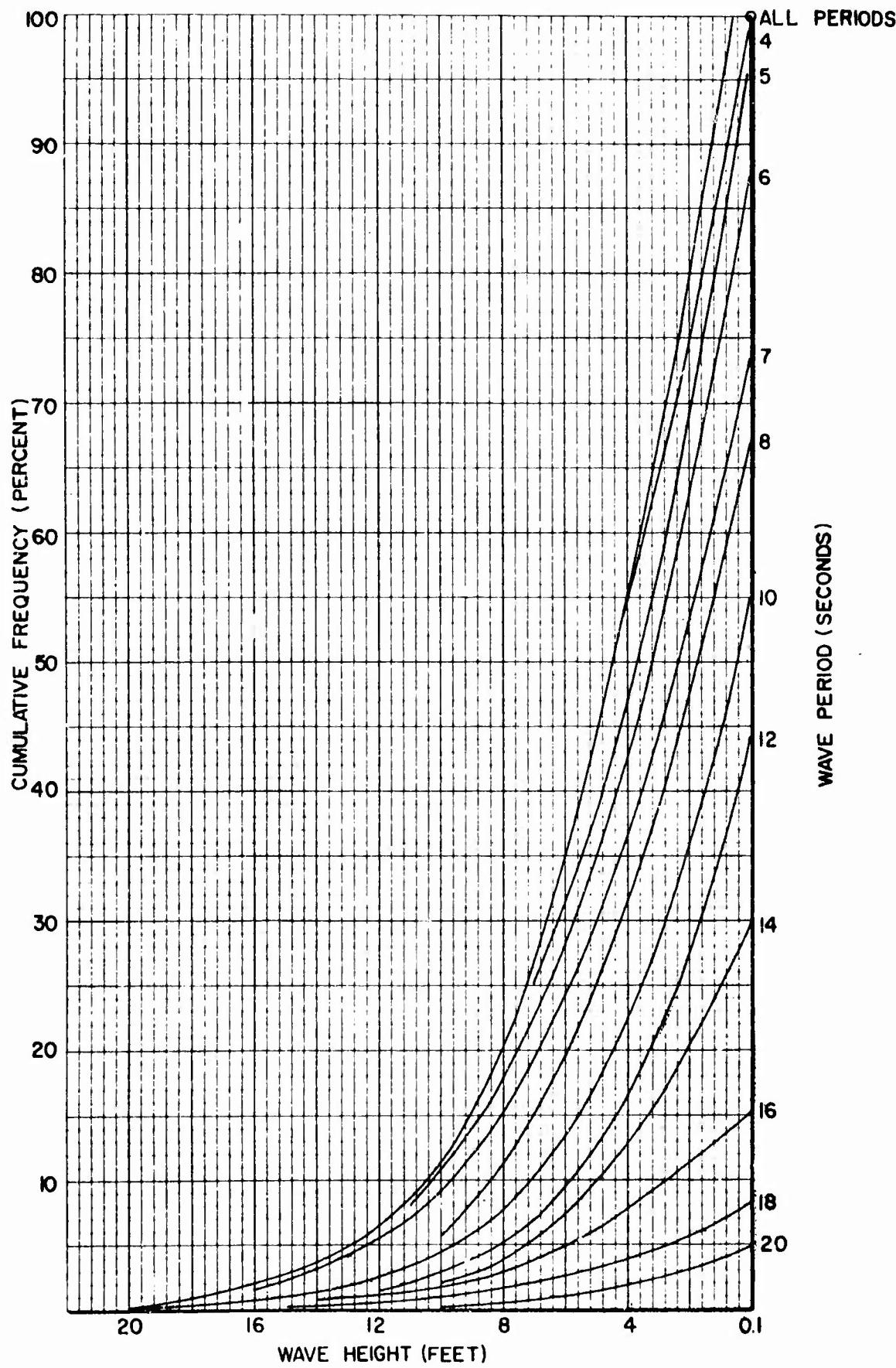


FIGURE B-7 - WAVE HEIGHT VS WAVE PERIOD
JULY - AUGUST - SEPTEMBER

B-13

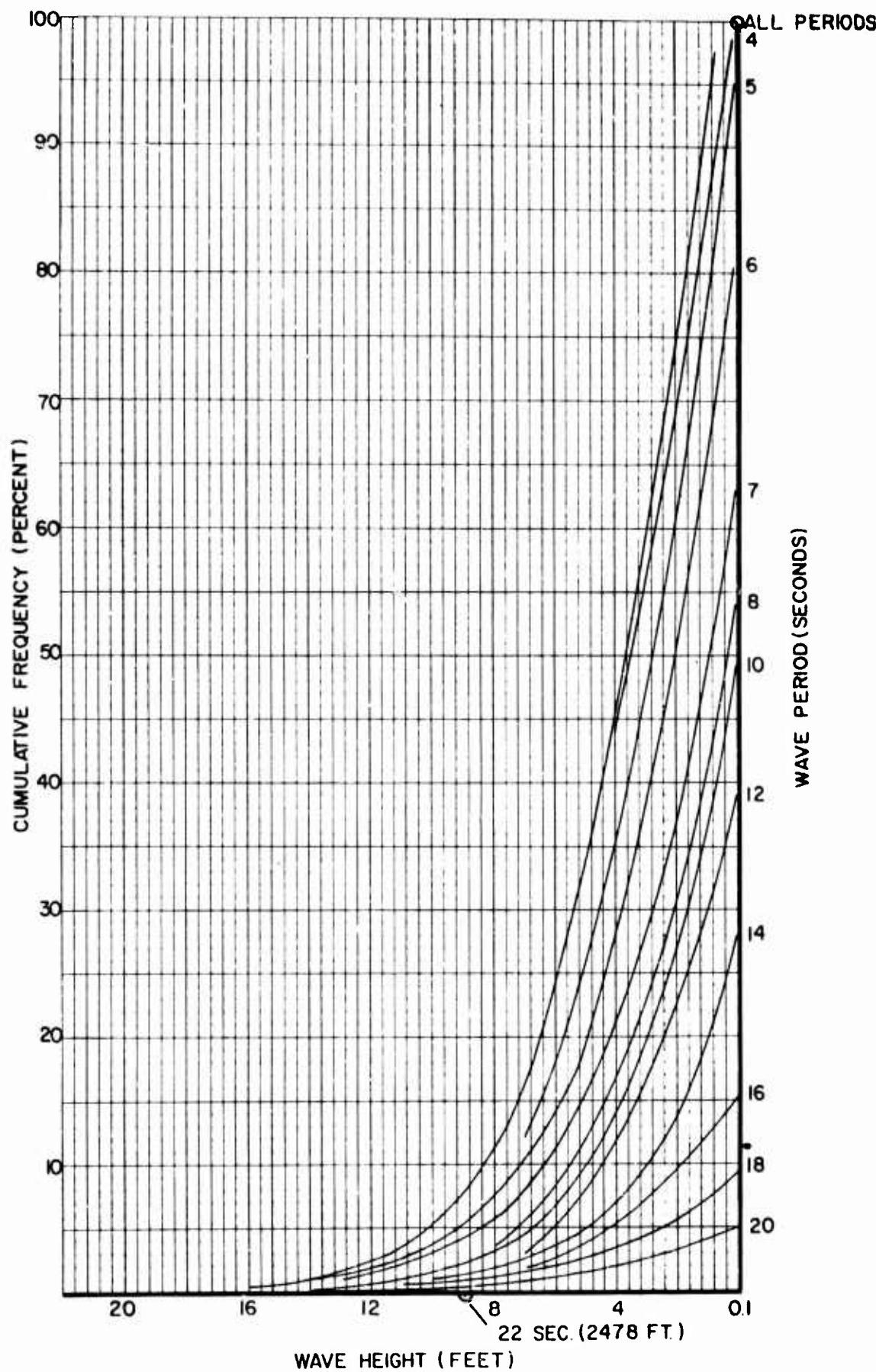


FIGURE B-8-WAVE HEIGHT VS WAVE PERIOD
OCTOBER - NOVEMBER - DECEMBER

B-14

APPENDIX C
RANGE INSTRUMENTATION SHIP'S CAPABILITY

Eastern Test Range (ETR) planning (Reference 10) indicates that the Range will be equipped with four types of Ocean Range Vessels suitable for the HSQ recovery mission. The vessels involved will be the USNS General Vandenberg, USNS Twin Falls, USNS American Mariner, USNS Sword Knot, and the USNS Coastal Crusader. Pertinent data on these vessels are listed below.

USNS VANDENBERG

I. DESCRIPTION OF ORIGINAL AND CURRENT FUNCTION, EQUIPMENT, AND CAPABILITY

USNS General Vandenberg, Range Instrumentation Ship (T-AGM-10) - RIS II, is a converted C4-S-A1 type troop ship. This RIS, originally christened General Taylor, is instrumented to provide the following support to aerospace test operations:

- Worldwide Monitor Man-In-Space Operations
- Missile System Evaluation
- Terminal Phase Trajectory Measurements
- Splashpoint Determination
- Nosecone Reentry Phenomena
- Evaluation of Decoy Sowing System
- Nosecone Recovery Operation
- Mid-Course Phase Trajectory Measurements
- Meteorology Measurements
- Satellite Intercept Evaluation

Description of Ship

- Length - 520 feet
- Beam - 72 feet
- Draft - 25 feet

Displacement - Full Load - 17,120 tons, light ship - 13,170 tons
Fuel Oil Capacity - 2,500 tons
Sustained Sea Speed - 16.5 knots (nontracking)
Engine - 9,000 hp steam turbine
Work and Living Areas - Fully air conditioned

Complement

Ship's Crew	- 90	(MSTS)
RCA	- 74	
PAA	- <u>9</u>	
Total	173	

RIS instrumentation can be classified into 9 subsystems: radar, data handling, communications, telemetry, timing, optical, stabilization and navigation, meteorological, and operations control.

A. RADAR SUBSYSTEMS (INTEGRATED INSTRUMENTATION)

The radar subsystem provides simultaneous trajectory and target signature data on a primary and two secondary targets. The subsystem consists of three radars operating at C-, L- and UHF-Band frequencies. Three separate targets can be simultaneously observed in real-time in each frequency band.

1. C-BAND TRACKER

The C-Band radar is used for skin and/or beacon tracking. It transmits and receives both horizontal and vertical polarizations for data gathering. The C-Band radar antenna is a 30-ft diameter parabolic reflector with Cassegrainian horizontal and vertical focal point feed systems. Its high-power transmitter pulse train includes both an FM skin-track pulse and a time- and width-coded beacon track pulse.

2. L-BAND RADAR

The L-Band radar, slaved to the C-Band tracker, gathers data on horizontal polarization. Its transmitter is capable of a 10-megawatt peak power output. The L- and UHF-Band radars share a 40-ft diameter parabolic antenna.

3. UHF RADAR

The UHF radar is vertically polarized and shares a portion of the 40-ft reflector with the L-Band radar. Its transmitter is capable of a 12-megawatt peak power output.

4. VIDEO CAMERA/RECORDING SYSTEM

This system is used to record range versus amplitude and range versus intensity data. Data is recorded on the following channels:

- C R/A (both horizontal and vertical)
- L R/A (both horizontal and vertical)
- X R/A (both horizontal and vertical)
- R/I (on C-, L-, and X-Band frequencies)

B. DATA HANDLING SUBSYSTEM

The data handling subsystem consists of Central Data Conversion and Control Equipment and Data Processing Equipment used as follows:

1. CENTRAL DATA CONVERSION EQUIPMENT

This equipment has two main purposes: to serve as an interface between the major subsystems (C-, UHF-, and L-Band radars, telemetry, stabilization and navigation) and the Univac 1206 Computer and to store all trajectory and nontrajectory data collected during a mission.

- 1 - Input/Output Converter Assembly
- 2 - A/D Converters
- 2 - Raw Data Recorders
- 1 - Synchro/Digital Converter
- 1 - AC/DC Converter

2. DATA PROCESSING EQUIPMENT

Calculations accomplished by data processing equipment include designation, navigation, tracking and real-time display formating. A Univac 1206 stored program digital computer has the capability of 32, 768, and 30-bit word random access memory. Peripheral equipment used with the computer includes:

1 - Magnetic Tape Recorder, Type 1245
1 - Paper Tape Reader and Punch, Type 1231
1 - High-Speed Printer
1 - Magnetic Tape Degausser
1 - Control Introducer
1 - Teletype, AN/UGC 13
2 - Teletype Adapters, 1262
1 - Test Set Card, 1250
1 - Central Control Station
 1 - M-G Set 1390
 1 - M-G Controller, 1389

C. COMMUNICATIONS SUBSYSTEM

This RIS has full capabilities to provide HF, VHF, UHF, and VLF teletype communications required to support Range operations.

1. HIGH-FREQUENCY (HF) RADIO

High frequency transmission is provided by one 10-kw and two 2.5-kw, dual channel transmitters and three 30.7-ft tall helical antennas. The transmitters have a frequency range of 4 to 25 mc and 2 to 30 mc respectively. Five HF receivers are fed from four 35-ft whip antennas.

2. ULTRA-HIGH FREQUENCY (UHF) RADIO

UHF ship to aircraft communications are furnished by a separate 50-watt transmitter and receiver with two discone antennas. The coverage is 225 to 399.9 mc with continuous monitoring of the 243 mc aircraft emergency frequency.

3. VERY-HIGH FREQUENCY (VHF) RADIO

VHF is provided by one 25-watt 100 to 160 mc VHF transceiver connected to a discone antenna and four portable VHF transceivers.

4. VERY-LOW FREQUENCY (VLF) RADIO

A 15-kc VLF receiver, 35-ft whip antenna and a RATT-converter allow VLF radio teletype reception.

5. TELETYPE COMMUNICATIONS

Teletype is provided by three teletypewriters, dual frequency shift tone keyers and frequency shift diversity combiners.

6. VOICE RECORDING

Voice recordings are accomplished by two 4-channel, 12-hr continuous operation recorders and one 4-channel playback reproducer.

7. INTERIOR COMMUNICATIONS

Communications aboard the vessel are facilitated by an automatic dialing PABX system. Twenty lines are used for instrumentation and 30 lines for administration. A 48-station capability PA system has a 165-watt power amplifier.

D. TELEMETRY SUBSYSTEM

Telemetry instrumentation aboard the vessel provide the capability to retransmit five simultaneous telemetry data links to orbiting vehicles. The five links can come from postdetected channels or up to four channels from a predetected recording.

1. TRACKING AND ACQUISITION SYSTEM

a. Antenna Assembly

- 1 - 30-ft Parabola Reflector
- 1 - Wideband Antenna (215 to 1,000 mc)
- 1 - Vertex Feed (13.5 kmc dual circular horns, conical scan 1200 rpm)
- 2 - Boresight Telescope
- 1 - Boresight Camera - 35 mm
- 1 - Retransmission Antenna

b. Preamplifiers

- 2 - 215-260 mc
- 1 - 260-300 mc
- 1 - 370-410 mc

1 - 875-1000 mc
2 - Preamp Converts
1 - Tracking Receiver

2. PREDETECTION RECEIVER RECORDER REPRODUCER SYSTEMS
FM, PAM, PDM/PACM, PCM - Data bandwidth 50 to 800 k bits/sec
30 mc IF Test, 5 mc IF data and retransmission 900, 450, 225 kc pre-detection recording.

8 - Receivers
8 - RF Heads (216-260 mc)
6 - RF Heads (260-300 mc, 370-410 mc, 875-1000 mc)
8 - Sets IF Bandpass Filters
2 - Spectrum Display Units
2 - Tape Recorders, 7-channel
2 - Pen Recorders, 8-channel
1 - Data Insertion Converter, 18-channel
1 - Audio Monitor

3. RETRANSMISSION SYSTEM

Five channels 30-watts/channel simultaneous retransmission, VHF converters predetected data 5-mc center 2.4-mc bandwidth, 5 FM transmitters video data 1.2-mc bandwidth - Multiplexed.

13 - Signal Amplifiers
8 - Mixers
5 - Power Amplifiers
5 - Local Oscillators
5 - FM VHF Transmitters
1 - Multiplexer and Directional Coupler

4. ASSOCIATED EQUIPMENT

1 - Test Antenna 13.5 kmc
1 - Test Antenna 400-1000 mc
1 - Test Antenna 215-420 mc
1 - Counter, 10 cps
2 - Reference Oscillators

E. TIMING SUBSYSTEMS

Timing information is supplied from a dual-time code generator which provides 12 types of digital codes, 6 types of pulse trains and 2 sine waves. Frequency synchronization is attained with a WWV and VLF receiver comparator. Stability is maintained with two frequency standards whose stability exceeds 5 parts in 10^{10}

- 1 - Dual Time Code Generator, MILGO
- 2 - Frequency Standards, Hermes
- 1 - Timing Signal Recorder, M-H
- 1 - WWV Receiver (HF)
- 1 - VLF Receiver-Comparator
- 1 - WWV/VLF Antenna and Duplexing Filter

F. OPTICAL EQUIPMENT SUBSYSTEM

Optical measurements are used to correct errors in instrumentation alignment due to ship flexure. The SINS platform is used as a reference. Two 2-axis flexure monitors measure the angular deflections about the ships yaw and pitch axis. One is used between the SINS platform and the C-Band radar mount, the other between the C-Band radar and the L- and UHF-Band mounts. Similar flexure monitors are mounted on the roll axis to measure ship twist.

1. FLEXURE MONITOR EQUIPMENT

- 1 - Flexure Monitor Console
- 2 - Receiver Terminal Boxes
- 2 - Transmitter Terminal Boxes
- 4 - Axis Receiver Base Plates
- 4 - Axis Transmitter Base Plates
- 2 - Twist Axis Receivers
- 2 - Twist Axis Transmitters
- 2 - Two Axis Transmitters
- 2 - Two Axis Receivers

2. TARGET ACQUISITION EQUIPMENT

 1 - MK-51 Gun Director

G. STABILIZATION AND NAVIGATION SUBSYSTEM

1. SINS MK IV

 1 - Gimbal Assembly
 1 - Navigation Console
 1 - Sealed Water System
 1 - On-Line Printer
 1 - Gimbal-Angle Repeater System

2. GYROCOMPASS MK-19 MODEL 3A

 1 - Power Supply Standby
 1 - Annunicator Compass Failure
 1 - Master Compass
 1 - Control Cabinet

3. STAR TRACKER

The star tracker locks on the position of a known star. A computer converts the angle information into digital form which is then supplied to the data handling computer. This computer uses a stored table of star ephemeris and precise time to give updating fixes to the SINS equipment and other navigation needs.

 1 - Digital Data Converter
 1 - Servo Amplifier Set
 1 - Optical Receiver Assembly
 1 - Director

4. ELECTROMAGNETIC LOG

Water Speed Measuring System

 1 - Speed Converter, YC-9
 1 - Indicator, Transmitter
 1 - Rodmeter

5. SONAR BENCHMARK SYSTEM

A sonar set is used with sonar benchmarks (bottom beacons) to update position information.

6. NAVIGATION AIDS

1 - X-Band Beacon, AN/APN-69

1 - C-Band Beacon, AN/DPN-66

1 - Lorac B System - This system provides position information for ship evaluation purposes.

1 - Receiver

1 - Actrac

1 - Brush Analog Recorder

1 - Digital Clock

1 - Digital Printer

1 - Digital Tape Reader

1 - Libroscope 210T XY Plotter

7. NAVIGATION CONTROL CONSOLE

The Navigation Control Console supplies readout data for the following: latitude, longitude, countdown clock, ship heading, velocity, propeller rpm, divergence and alarm indications.

H. METEOROLOGICAL EQUIPMENT SUBSYSTEM

A complete weather station is established aboard ship for obtaining weather data up to 250,000 feet.

1. SURFACE DATA SYSTEM

1 - Wind Direction and Speed Indicator ID 373/GMQ-11

1 - Mercurial Barometer, Marine

2 - Aneroid Barometers ML 331/TM

1 - Psychron - Humidity

4 - Psychometric Computers

2 - Humidity - Temp Computers

1 - Temp and Dew Point Sensor AN/TMQ-11

- 1 - Temp and Dew Point Recorder
 - 2 - True Wind Computers
 - 1 - Microbarograph Belfort 566
 - 1 - Aerovane AN/GMQ-11
 - 1 - Surface Pressure Inst
2. 2,000 ft
- 1 - Wiresonde AN/UMQ-4
 - 1 - Tether Winch
 - 2 - Balloons J8D
3. 100,000 ft
- 1 - Radiosonde (mod for boresight) (403 mc) AN/AMQ-9
 - 1 - Antenna and Ped Assy. AN/GMD-2
 - 1 - Automatic Data Converter
 - 1 - Radiosonde Recorder AN/TMQ-5
 - 1 - Radiosonde Transmitter T456/GMD 2 (403 mc)
 - 1 - Calibration Test Antenna
 - 1 - Radiosonde Calibration Chamber AN/GMM-3
 - 1 - Plotting Board ML-514/TM
 - 2 - Theodolite and Tripods
 - 100 - Balloons ML-518/AM
 - 1 - Balloon Inflation and Handling Equipment
 - 200 - Radiosonde Set AN/AMT-12, AN/AMQ-9
 - 1 - Radiosonde Receiver R301/GMD1B (403 mc)
 - 1 - Signal Comparator CMG-GMD-2
4. 250,000 ft
- 1 - Rocket Launcher and Gas Gen EX120 Mod 06
 - 1 - Arcas Fire Control Station I
 - 1 - Arcas Fire Control Station II
 - 1 - Arcas Fire Control Station III

I. OPERATIONS CONTROL CENTER SUBSYSTEM

The Operations Control Center serves as the ship's Central Control Station during tests. It contains the following equipment:

- 1 - Master Control Console - Manned by the SIM and SOM, this console displays the present status and mode of operation of data gathering instrumentation during test operations.
- 1 - Designator Control Console - The Designate Controller utilizes this console to select the desired master designate source (of acquisition).
- 1 - Target Trajectory Plotter - Missile trajectory data is plotted in terms of latitude, longitude, range, and altitude.
- 1 - TV Monitor
- 1 - Master Countdown Indicator
- 2 - Voice Tape Recorders

II. POTENTIAL FOR MEETING CURRENT AND FUTURE NEEDS

The following modifications and instrumentation are programmed for this vessel:

Installation of Ships Inertial Navigation System	Required Operation Date (ROD) FY 66
Real-Time Telemetry System	
Radar Data Handling System Interface	ROD FY 65
L-Band Radar Equipment	
Predetection Receiving and Recording Telemetry Systems, TRK 1-12	ROD FY 65
S-Band Telemetry Preamplifier Frequency Converter/Data Receiver System	ROD FY 65
L-Band Radar (Supplies and Services)	ROD FY 64
Engineering Analysis, Design and Equipment Improvement	ROD FY 65

USNS TWIN FALLS

I. DESCRIPTION OF ORIGINAL AND CURRENT FUNCTION, EQUIPMENT, AND CAPABILITY

The Twin Falls is a modified victory ship instrumented to provide extremely precise C-Band radar data and VHF-and S-Band telemetry coverage on ballistic missiles in flight. This Range Instrumentation Ship is also equipped to support recovery operations.

Description of Ship:

Length - 455 feet

Beam - 62 feet

Tonnage - 7,606 gross tons

Speed - 16 knots

Propeller - Single Screw

Engine - Steam Turbine, 8,500 hp

Draft - 20 feet

Cruising Speed - 18 knots (max), 15 knots (tracking)

Living Quarters - The ship has 27 staterooms and a 16-man bunkroom to provide accommodations for PAA and RCA personnel. The bunkroom is considered temporary quarters. All quarters are air conditioned.

Present on-board complement:

PAA - 4

RCA - 39

Ship's Crew - 60 (MSTS)

Total - 103

The ship is equipped with the following systems and instrumentations:

A. AN/FPS-16 RADAR SYSTEM

The AN/FPS-16 is an automatic tracking C-Band radar which is designed to acquire and transmit trajectory data in real-time. The ship's

attitude information is derived from the N7C stable reference platform or MK-19 gyrocompass.

B. TELEMETRY SYSTEM

The Twin Fall's telemetry system consists of three antenna assemblies: VHF crossed dipole array; S-Band CTS dish antenna (12-ft diameter); and a broadband (hand steerable) array capable of receiving telemetry signals of 136 mc - 2300 mc. The telemetry system onboard also includes the receiver, data conversion, and recording equipment outlined below. Telemetry data may be used to supply acquisition data to the radar. Signal strength and frequency outputs are recorded on graphic recorders and telemetry intelligence is recorded on magnetic tape recorders.

C. COMMUNICATIONS SYSTEM

Supporting ship's instrumentation requires communication with the control station at Cape Kennedy and with range stations. Two Collins 10 kw single-sideband transmitters provide 4 channels of communications for either voice or teletype. Normally one channel is used for administrative teletype traffic. One channel provides voice communication with the Superintendent of Range Operations. A third provides a voice link with the Cape Radar Controller. The fourth channel is a spare. Two KWTG Collins 500-w single-sideband transceivers are installed to provide voice and teletype communications with other RIS's and land stations which act as net control stations. A UHF receiver-transmitter unit is used as a communications link to supporting aircraft.

D. TIMING SYSTEM

A basic 1 pps signal is generated, synchronized with WWV and connected for propagation delay. From this basic signal, various codes are generated to provide the different timing pulses required. Timing codes are recorded with the missile data to provide time-references.

E. SHIP'S ATTITUDE INFORMATION SYSTEM

On the Twin Falls a second system can provide azimuth and ship attitude information, if the N7C malfunctions. This second system is the Sperry MK-19 Gyrocompass. Less accurate than the N7C, the MK-19 output produces slightly-degraded data. To record outputs from the various systems, outputs are converted to binary form, then recorded on magnetic tape. These data sources include the FPS-16, timing, MK-19, and N7C. The data are then flown back to PAFB for processing.

1. DATA HANDLING

- 1 - Transmitter, Data Encoder, 21 Digit Milgo Model 1002T
- 1 - Converter, Coordinate, Cartesian to Polar, Electronics Associates Model 3575-31B
- 2 - Recorder, Tape, Seven-Track Direct Record, and Direct Reproduce Amplifiers, Ampex FR11100 Series
- 2 - Converter, Data, Digital Milgo Model 165
- 1 - Converter, Data, MK-19, roll, pitch, and heading, Mfg. Feedback Controls Inc.
- 1 - Computer and Peripheral Equipment, RCA Model 4101
- 1 - Synchroamplifier roll, pitch, and heading, Type F MK-31 Mod 8

2. IMPACT AREA INSTRUMENTATION

- 1 - Electromagnetic Log, Litton Inc
- 1 - Gyro Compass, Model MK-19 Sperry Gyro Company
- 1 - Recorder, Oscillograph, Direct Wiring, 24 channel, Visicorder, Honeywell Model 1108
- 2 - Hydrophone, Atlantic Research Corporation, Type BC-50
- 1 - Amplifier System, Linear/Integrate, Channel with power supply Heiland Model 119
- 1 - Autonavigator System N7C North American Aviation (Autometrics Division)
- 1 - Sounding Navigational Radar Set, AN/UQN-1 (Sonar), EDO Corp Model 185

3. METEOROLOGY

- 2 - Wind Measuring Set, AN/GMQ-11

4. OPTICS

- 1 - Camera, 4 x 5 inch, Pacemaker Still, 45 Graflex
- 1 - Director, Gun MK-51
- 2 - Camera, 35mm, Boresight, Radar Model 433, Fed Mgr & Engr Co
- 1 - Camera, Oscillograph, Record, Model 321A

5. RADIOMETRIC

- 2 - Panadapter, SA3/3000CI
- 2 - Receiver, Radio R-390A/URR

6. RADAR

- 1 - Radar Set AN/FPS-16, Modified, C-Band Tracking Radar; AN/FPQ-6 Improved C-Band Tracking Radar
- 2 - Transponder, AN/DPN-54, C-Band, Model I (XCC-1) Motorola
- 1 - Recorder, Event, 60 Channel, Techni-Rite Elec Model TR6260
- 1 - Coder, Pulse, Transmitter, for C-Band Radar
- 1 - Simulator, Moving Target, Remanco Inc Model RP-175 and Model 8007

7. TIMING AND FIRING

- 1 - Timing System, Ship, Model 36800, 17 Digit
- 1 - Receiver, VLF, Pickard and Burns Model 3144 with Phase Comparator
- 1 - Frequency Standard, 100 kc, Hermes Model 105A and Manson Models RD-180 and RD-180A
- 1 - Scanner, 1 pps, 17 Digit, Model 36870A
- 2 - Timing Terminal Unit, Model 1464
- 1 - Timing Terminal Unit, Models 1463, 1463A, and 1463B
- 1 - Timing Terminal Unit, Model 90000, with Logic Power Supply Model 90010 and Load Power Supply Model 90070 and one spare
- 6 - Pulse Shaper, Model 90040 and two spares
- 1 - Driver Unit, Sine Wave Model 90050 and one spare

8. TELEMETRY

- 1 - Broadband Hand Steerable 136 mc thru 2300 mc
- 1 - Antenna, Automatic, Tracking for Range Vessels
- 3 - Antenna, Telemetry Omnidirectional, for Range Vessels Holloway H19050-2
- 1 - Antenna, Automatic Tracking, Quad Helix, Medium Gain (changed to a Crossed Dipole Antenna)
- 1 - Amplifier, RF Distribution, Nems-Clarke Preamplifier/Multicoupler PM 406, consisting of one PR203 Preamplifier and one MC 406 Multicoupler
- 1 - Multicoupler, 135 mc; Nems-Clarke Model MC406-45, 960 mc and 136 mc; and Defense Electronics TMC6, 906 mc and TMC5 136 mc
- 8 - Receiver, Crystal Controlled, Nems-Clarke Models 1401 and 1401A
- 1 - Receiver, VHF/UHF, 100-2300 mc, TMR Defense Electronics, Inc
- 1 - Receiving and Storage Subsystem for Program 620A, Ship Based
- 1 - S-Band Telemetry System for T-AGM-11 and C1M-AVI Ships
- 2 - Recorder, Reproducer, magnetic, 7-track, 1/2 inch tape, CEC Type 5-752, TLM-28
- 4 - Converter, Data Insertion, TLM-8, Parsons and Hallamore Electronic
- 2 - Monitor Mixer Unit, TLM-35 Radiation and Century
- 2 - Recorder, Signal Strength, Direct Writing, 8-channel, Sanborn Model 150 and others
- 1 - Receiver/Recorder Distribution Rack, TLM-20, Stromberg-Carlson, and Centronix
- 2 - Monitor, Nems-Clarke, RF, Model 1402F, part of TLM-15 Monitoring and Recording System
- 18 - Discriminator, EMR 167 and EMR 167A part of Data Separation and Recording System, EMR 56-7828
- 1 - Time Division Multiplex, Ship Based for Program 620A
- 1 - Panoramic Telemetering Indicator, Models TMI-1, TMI-1A, and TMI-1B
- 1 - Supply, Power DIC, New Jersey Elec, Model TR-361 and TR-362, for Data Insertion Converters

2 - Oscillator, Reference, TLM-16 100 kc Century
1 - Cart, Test, Model CEC 23-203 for CEC 5-752 Recorder
1 - TMR-5A Receiver Test Kit
3 - Preamp LEL TP-5 (used in Autotracking system) and one spare
1 - Preamp 960 mc, DEI RPA-8 No. 103
1 - Multicoupler, Nems-Clarke MC-406-45-237, Ser No. 435
2 - Tuning Unit, 920-960 mc DEI TMH-J5
2 - Video Unit, DEI-A5 Ser No. 110 and 112
1 - Demodulator, Phase, DEI PMD-A5/A Ser No. 101
2 - Demodulator, Phase, DEI PMD-A5, Ser No. 109-110
1 - Amplifier, IF, 10 mc DEI IF A-D5 Ser No. 104
1 - Amplifier, IF, 10 mc DEI IF A-E5 Ser No. 108
1 - Amplifier, IF, 10 mc DEI IF A-H5, Ser No. 129
1 - Digital Bar graph 40 channel, Monitor Systems Inc

a. Communications Equipment

Antennas:

1 - Doublet, Tri-Double Interim Installation
1 - Discone, Cage Collins 3-30 mc, Primary Radio Transmitting Antenna
5 - Whip, 35-foot
2 - Wire, Long, Vertical, 35-foot
1 - Wire, Long, Horiz (Broadcast Band)
1 - Discone, VHF
2 - Discone, UHF

9. RECEIVE ANTENNA TUNERS

2 - Technical Materials Corp Mod ATS2
2 - Technical Materials Corp Mod ATS2 (Cougler)
1 - Collins 180T-2 (Coupler)

10. RECEIVE FILTERS

- 1 - Collins 635R1 (2-30 mc), Tunable
- 1 - AN/SRA-12C (Range 14 kc - 32 mc, Bandpass)

11. TRANSMITTERS

- 2 - Collins 204C, 10 kw PEP
- 2 - Collins KWT-6, 2-30 mc, 500 watts PEP, Single-Sideband Transceiver
- 1 - Wilcox 406-A, VHF Xmtr
- 1 - T-217A/GR, UHF
- 1 - T-282/GR, UHF

12. RECEIVERS

- 1 - Collins 50E6D, Single-Sideband Diversity Receiver
- 4 - SP 600 Hallicrafter General Coverage Radio Receivers
- 2 - R-390/UUR Military Standard HF Receivers
- 1 - Collins 51 M-2, VHF Receiver
- 1 - R-278/GR, UHF
- 1 - R-361A/GR, UHF

13. CONVERTERS

- 1 - Technical Materials Corp MSR4, Single-Sideband
- 2 - CV 157/URR Single-Sideband Converter, used with R-390 Receiver

14. TELETYPE

- 8 - Northern Radio, Type 211 Mod 2 Keyers (Transistorized)
- 4 - Northern Radio, Type 212 Mod 2 (Transistorized), Tone Converters
- 1 - Northern Radio, Type 153 Mod 3, Keyer
- 1 - Northern Radio, Type 152 Mod 3, Converter
- 4 - Teletypewriter, Kleinschmidt Mod 20
- 4 - Teletypewriter, Teletype Corp. TTY Xmtr Type TT-52
- 3 - Reperforator, Kleinschmidt, Mod TT 107 (Receive Only)
- 1 - Teletypewriter, Kleinschmidt, Mod 25
- 1 - AN/FGC-60, Teletype Multiplex Terminal
- 1 - Comm Security Equipment

II. POTENTIAL FOR MEETING CURRENT AND FUTURE NEEDS

This vessel will be considered adequately equipped to fulfill anticipated requirements with the installation of the following programmed equipment:

Marine Modification for instrumentation of Twin Falls	ROD FY 65
Stellar Inertial Navigation System	ROD FY 66
S-Band Telemetry Preamplifier Frequency Converter/ Data Receiver System	ROD FY 65
Radar Collimation System	ROD FY 65
Acoustic Ship Positioning System on Twin Falls, T-AGM-11 with Transponders on Ocean Bottom	ROD FY 65
Parametric Amplifier (C-Band Radar)	ROD FY 66
Communications Interface	ROD FY 66
Satellite Navigation System	ROD FY 67
Analog Computer	ROD FY 66
High-Speed Data Transmission System	ROD FY 67
Improved HF Transmitting Antenna	ROD FY 66
Automatic Tracking S-Band Telemetry Antenna for the Twin Falls T-AGM-11	ROD FY 65
Improved HF Transmitting Antenna System	ROD FY 66
Programmed Communications Equipment	
O/L TT Crypto Duplex Synch	ROD FY 65
Modifications to vessel required to receive programmed instrumentation equipment:	

- Telemetry Rehabilitation
- Provide new office, stores, and recreation space
- Install MK-4 SINS Equipment
- Provide Navigation Control area
- Provide new technicians and ship crews quarters
- Install one new 300-kw turbogenerator and control
switchboard
- Provide an electrical distribution switchboard section
- Install air-conditioning unit
- Install new HF Communications Antenna and miscellaneous
antennas relocations
- Marine maintenance and overhaul

USNS AMERICAN MARINER

I. DESCRIPTION OF ORIGINAL AND CURRENT FUNCTION, EQUIPMENT, AND CAPABILITY

The American Mariner is a converted liberty ship equipped with instrumentation for observing launch vehicles during the reentry phase of their trajectory. This RIS is instrumented to provide radar, optical, data handling, and communications support to the ETR.

Description of Ship:

Length - 441 feet

Beam - 56 feet

Draft - 21 feet

Displacement - 10,650 tons

Engine - 2,500 hp

Speed - 8-10 knots

Main Generators - 2 each 600 kw

Aux Generators - 2 each 1500 kw

Living Spaces - 81 staterooms located on the boat, bridge,
upper, first, and second decks; provide accommodations for officers, crew, and
technical personnel assigned to the vessel.

Manning - The manpower required to maintain, operate and
service the American Mariner is listed below:

Administration

Ship's Operation Manager	1
Asst Operation Manager	1
Staff Assistant	1
Supply	3
	—
	6

Administration (Continued)

6

Instrumentation

Management/Support/Administration	10	
Radar	19	
Data Handling/Recording	16	
Communications	8	
Operations & System Integration	3	
Infrared	8	
Documentation/Maintenance Control	<u>2</u>	
	66	66
<u>Operations Control*</u>		
Operations Planning	3	
Engineering Support	4	
Drafting	<u>1</u>	
	8	8
<u>Ship's Crew (MSTS)</u>	60	<u>60</u>
Total		140

Installed instrumentation includes two AN/FPQ-4 C-Band tracking radars, dual UHF/L-Band radar and S-Band (Mod II) radar, for use in obtaining missile trajectory and, also, radar cross-section reentry data. Ordinarily the UHF-/L- and S-Band are slaved to one of the C-Band radars during a mission. Target acquisition is established by analog- or digital-computer programming or by optical instruments. The ship also contains equipment (Gyros) necessary to remove ship's motion from the radar pointing angles and communications systems for point-to-point, air-to-ground, ship-to-shore and intrastation communications. A timing system furnishes the proper timing signals to the various subsystems. Analog, video, and digital recorders store the data obtained during a mission.

Instrumentation Summary(1) Pulse Radar

2 - C-Band Tracking AN/FPQ-4

*Temporary Duty - The above manning is subject to change at any time.

1 - I - UHF-Band Reflectivity, RCA
1 - S-Band Reflectivity, Mod SCR-584
2 - Analog Range Machines

(2) Optics

2 - Optical Director, MK-51 Mod 3
4 - Ballistic Camera
1 - 16 mm High-Speed Camera
3 - 35 mm Boresight Camera, Flight Research IVC
1 - 70 mm Boresight Camera

(3) Infrared

1 - Tracker, Barnes 21-122D
4 - Spectral Ballistic Camera
2 - 70 mm Sequence Spectrograph
1 - 50 Element Scanning Radiometer
1 - 70 mm UV Cine Spectrograph
2 - Radiometer, R4K-1
1 - Four Channel Photometer

(4) Data Handling

Acquisition Director:

1 - Test Console
1 - System Switching
1 - Digital Computer, RCA RADAP-C
1 - Input-Output Buffer Unit

Designation & Stabilization Equipment:

1 - Designation Console
2 - Designation Analog Computer
2 - Stabilization Angle Solver

(5) Data Recording

Digital Recording:

3 - CEC T-00524 Digital Recorder
5 - Digital Power Supply
1 - Digital Storage & Readout
1 - Data Processing Console
1 - Analog/Digital Converter

Analog Recording:

- 3 - Ampex FR-100, Analog Recorder
- 5 - Sanborn, Chart Recorder
- 1 - Galvanometer Oscillograph, CEC
- 2 - Time & Events Recorder
- 1 - Scope Recorder
- 2 - Audio Recorder (4 Channel) Magnetcord F35B

Video Recording:

- 2 - Video Recorder (magnetic tape), RCA
- 1 - Multiplexer
- 2 - Video Multiplier
- 2 - Recording Distribution Patch Panel

(6) Navigation

- 2 - Gyro Compass, Sperry MK-19
- 1 - Heading Indicator
- 1 - Electromagnetic Log, Litton Inc
- 1 - Speed & Distance Indicator

(7) Communications

Interstation:

- 14 - HF, VHF UHF Antennas
- 1 - Antenna Switching Array
- 3 - HF, VHF, UHF Transmitters/Receivers
- 2 - HF, VHF Control Unit
- 3 - HF Transmitter
- 2 - Transmit Control Unit
- 1 - Timing Receiver, Special Products
- 1 - Muting Relay
- 1 - Antenna Junction Box
- 1 - Multicoupler
- 12 - HF Receiver
- 2 - Converter, CV 157

1 - Audio Distribution Panel
4 - Speaker Panel
1 - Teletype Patch Panel
4 - Dual Frequency Shift Converter
1 - Frequency Shift Converter CFA
1 - Frequency Shift Keyer Converter (100 wpm) CV60
7 - Teletypewriter
1 - Communication Console
1 - Communication Control Panel
1 - Jack Box
1 - Push-to-talk Switch
2 - Crypto Set

Intrastation:

1 - Public Address System
1 - Intercommunication System (MOPS)
1 - Sound Power Telephone System
1 - Stateroom Dial Telephone System

Television Monitoring:

1 - TV Camera
1 - Monitor Unit

(8) Timing

2 - WWV Receiver, Bechmann 905
1 - Oscilloscope, Waterman Products S-12-B
1 - Scope Panel
2 - Oscillator Clock Manson Labs RD 144
2 - Frequency Divider
2 - 13, 17 & 24 Bit Timing Generator, Hermes
1 - Line Amplifier
2 - Distribution Panel

(9) Power

2 - Turbogenerator, Westinghouse
2 - Turbogenerator Control Panel
1 - Main Power Distribution Panel
6 - Inductrol
1 - DC Supply
2 - Transmitter Control Panel
24 - 10 kva Transformer
6 - 7.5 kva Transformer
1 - Electronic Area "A" Distribution Panel
1 - Power Status Panel
1 - Power Distribution Panel
2 - Magnetic Control Panel
2 - Speed Regulation Panel
1 - Area "B" Distribution Panel
2 - 400-Cycle Voltage Regulator
1 - Distribution Panel

II. POTENTIAL FOR MEETING CURRENT AND FUTURE NEEDS

The following programmed instrumentation will increase the capabilities of this Range Instrumentation Ship:

Communications Equipment:

O/L TT Crypto Duplex Synch	ROD FY 65
Video Recording Equipment	ROD FY 65
Communications Subsystem	ROD FY 65

Radar Systems Equipment:

Autotrack Equipment for Quad Helix Antenna	ROD FY 65
Digital Range Unit for the AN/FPQ-4 Radar	ROD FY 65

Parametric Amplifier System	ROD FY 65
Radar Depot Level Maintenance	ROD FY 66
Radar Data Handling System	ROD FY 65

Modifications to vessel required to receive programmed instrumentation equipment: FY 65

- Relocate SIMS Office
- Relocate S-Band Radar Antenna,
Electronic Equipment
- Relocate P-Band Telemetry Antenna
- Install P-Band Electronic Equipment
- Install Telemetry Rehabilitation Equipment
- Install Digital Computer and Video Recording
Equipment
- Provide Communications Receiver Area, Transmitter
Area, Crypto Area, Operations Control Center and
Communications Message Center

USNS SWORD KNOT

I. DESCRIPTION OF ORIGINAL AND CURRENT FUNCTION, EQUIPMENT, AND CAPABILITY

USNS Sword Knot, Range Instrumentation Ship (C1-M-AV1) — The primary function of this RIS is to provide telemetry coverage for the terminal portion of ICBM flights. The ship is also equipped with special equipment for recovery of nosecones and data capsules and to collect weather data. RIS's operate in the Atlantic from Cape Kennedy to Ascension and St. Helena. They occasionally make trips to the Indian Ocean for extremely long-range operations. Ports of call are Antigua, BWI; Trinidad; Recife, Brazil; Capetown and Durban, South Africa; and Ascension Island. The communications call name for this ship is YANKEE.

Description of Ship:

C1-M-AV1 Characteristics

Length - 335 feet

Draft - 18 feet

Weight - 4000 gross tons

Propeller - Single screw

Engine - Diesel 1700 hp

Main Generators - 2 dc, 300 kw each (may be paralleled to double capacity)

Cruising Speed - 10 knots

Range - 22,000 miles (max)

Auxiliary Equipment - Evaporator for manufacturing fresh water; air conditioning for instrumentation and living quarters; walk-in deep freeze compartment for frozen meats; chill boxes for fresh vegetables, eggs, etc; machine shop for small machine work.

Living Spaces - Crew living spaces are under the bridge on the main deck (main deck is the first, or highest, complete deck on a ship). The ship's galley, crew's washrooms, and ship's laundry are in this area. The laundry is located in the crew's quarters area in a small compartment aft of the crew's messroom.

The engineering officer's quarters are also on the main deck, beneath the bridge on the port side. The deck officers' quarters are on the first level above the engineering officers' quarters. The officers' messroom is also on this level and is used by the ship officers and PAA/RCA personnel. The captain's quarters are on the next level above the deck officers' quarters. The captain's office and quarters are together on this level.

The PAA/RCA living quarters are midship below the main deck. Staterooms each have bunks, storage lockers, and drawer space for two persons. A shower and head is located between each two staterooms, with access from either side. The rooms are air conditioned and have no portholes. Two recreation rooms are also located in this area. One is reserved for the ship's officers and PAA/RCA personnel and the other for the crew.

RCA personnel	-	9
PAA personnel	-	5
Ship's Crew	-	<u>40</u> (MSTS)
Total		54

This ship is equipped with the following systems and instrumentation:

A. TELEMETRY SYSTEM

The telemetry signal transmitted from an airborne missile is picked up on a broadband log periodic, a 7-turn helix or quad disc antenna. Antennas are coupled to 1 or more of 12 receivers through preamplifiers and multicouplers. Each receiver has three outputs: signal strength, frequency, and telemetry intelligence. Signal strength and frequency outputs are recorded on graphic recorders; telemetry intelligence on magnetic recorders. Both types of instruments record timing signals along with data to provide time-correlation.

After the telemetry data is collected, it is packed in locked cases and shipped to RCA Data Processing at Patrick AFB. This data when collected is unclassified because it is "raw" or unrelated.

B. COMMUNICATIONS SYSTEM

Communications equipment is provided for direct communications with area net control stations at Ascension, Antigua, RWI, or Cape Kennedy and PAFB, so that flight schedules and other information may be furnished to telemetry operations. Communications from the ship to aircraft is also a necessity.

C. TIMING SYSTEM

A timing code is generated from a master frequency standard that is calibrated and synchronized with Bureau of Standard Station WWV.

1. INSTRUMENTATION SUMMARY

- 1 - Precision Depth Recorder, Westrex Mark XI
- 1 - Sounding Navigational Sonar Set, AN/UQN-1 EDO Corp Model 185
- 1 - Wind Measuring Set AN/GMQ-11
- 1 - Navigation Radar Set AN/SPN-18, CR104
- 1 - Telcar (Telemetry Carrier and Recovery DF) Direction Finding System
- 1 - Comparator/Receiver, WWV, Model WWVC
- 1 - Ship Timing System, Model 36800, 17 digit
- 1 - Telemetry 7-Turn Single Helical Antenna
- 1 - Broadband Log Periodic Telemetry Antenna
- 1 - Telemetry Quad Disc-on-Rod TAA-1 Antenna
- 2 - Omnidirectional Telemetry Antenna, Holloway H.-19050-2
- 2 - Houston Fearless Pedestal, RCP-6, 45° Elevation. Mounts for the 7-Turn Helix (stbd) and Broadband Log Periodic (port)
- 1 - TAA-1 Pedestal and Amplidyne Drive Unit, Dynatronics
- 1 - AN/FPN-13 Radar Beacon (Dual)
- 2 - Antenna Control Unit for 7-Turn Helix Pedestal (RCP-6)
- 1 - S-Band Preamplifier and Down Converter System consisting of:
 - 1 - Preamplifier
 - 1 - Down Converter
 - 1 - Frequency Standard
 - 1 - Control Panel

- 1 - Space General Special Data Receiver Model RTD5000B
- 2 - Antenna Control Unit for 7-Turn Helix Pedestal (RCP-6)
- 1 - Signal Strength Amplifier, Nems-Clarke Model SSA-100,
with dual meters for comparing signal strength of telemetry
receivers
- 1 - Multicoupler TMR-5 Receiver
- 2 - Teledome for the 7-Turn Helix (starboard) and Broadband
Log Periodic TLM Antenna (port)
- 1 - Telemetry Data Retransmission System RT-100
- 2 - Preamplifier for 7-Turn Helix
- 3 - Preamplifier for TAA-1 Antenna, Resdale Model 91170
225/260
- 4 - RF Distribution Amplifier, Nems-Clarke PR 203 Preamplifier
and one MC 406 Multicoupler
- 12 - Telemetry Receiver, Nems-Clarke crystal controlled
Model 1401
- 2 - VHF-UHF (100-2300 mc) Telemetry Receiver, TMR-5A
Defense Electronics
- 2 - Amplifier Chassis Video Distribution with four amplifiers
- 3 - Telemetry Recorder, Magnetic 7-track, 1/2 in. tape, CEC
Type 5-572, TLM 28
- 2 - Dual Data Insertion Converter, TLM-8 Parsons Electronics
- 8 - Data Insertion Converter, Hallamore Electronics
- 2 - Mixer Monitor TLM 35
- 1 - Oscillograph Recorder CE 5/123 used with 6 each EMR 167
Discriminators as a Data Separation and Recording System,
EMR 56-7828
- 2 - Signal Strength Recorder, Direct Writing, 8 channel, Sanborn
Model 150
- 1 - Receiver/Recorder Distribution Rack, TLM 20, Stromberg
Carlson
- 2 - RF Monitor, Nems-Clarke Model 1402F, part of TLM-15
Monitoring and Recording System
- 1 - DIC Calibrator and Discriminator, Multichannel, Air Pax,
TLM 121
- 6 - Discriminator, EMR 167, part of Data Separation and Recording
System, EMR 56-7828

1 - DIC Power Supply, New Jersey Elec, Model TR3-161
2 - Reference Oscillator, TLM-16, 100 kc Century
1 - Test Cart, CEC Model 23-203 for CEC 5-752 Recorder
1 - TMR-5A Receiver Test Kit

2. COMMUNICATIONS EQUIPMENT

1 - HF FRT 15 Transmitter
1 - 204 C Linear Amplifier
1 - 310 F6E SSR Exciter
4 - HF SP 600 Receiver
1 - R-390A HF Receiver
1 - CU-157 Single-Sideband Converter
1 - HF Receiver Bandpass Filter, Mod 635R1

1 - VHF 408A Transmitter
1 - VHF 51M2 Receiver

2 - UHF T282 Transmitter
3 - UHF R361 Receiver

1 - Motorola Compa Station, VHF Transceiver Model C53G
KB 1000A
3 - Magnacord Audio Tape Recorder

1 - FGC - 20 Teletypewriter
1 - FGC - 52 Teletypewriter
1 - 152 Tone Converter
1 - 153 Tone Keyer
1 - 107 Frequency Shift Polar/Neutral Teletype Converter

II. POTENTIAL FOR MEETING CURRENT AND FUTURE NEEDS

During Calendar Year 1965 this vessel will undergo shipyard modification. The following instrumentation is programmed for installation as indicated:

Stable Reference for Rawin Set SN/GMD-1

Marine Modification for Instrumentation
of Sword Knot

ROD FY 66

S-Band Telemetry Preamplifier Frequency
Converter/Data Receiver System

ROD FY 65

Improved HF Transmitting Antenna System

ROD FY 66

Programmed Communications Equipment:

Single-Sideband Voice HF Medium
Power Terminal

Modifications of the vessel to receive
instrumentation equipment

FY 65

Installation of S-Band Telemetry

Improved Communications

Additional Quarters

Other Minor Modifications

Modifications of the vessel to receive instrumentation
equipment

FY 66

Installation Communications Interface

High-Frequency Radio Data Transmission

Minor Modifications

USNS COASTAL CRUSADER

I. DESCRIPTION OF ORIGINAL AND CURRENT FUNCTION, EQUIPMENT, AND CAPABILITY

USNS Coastal Crusader, Range Instrumentation Ship (C1-M-AV1) - The primary function of this RIS is to provide telemetry coverage for the terminal portion of ICBM flights. The ship is also equipped with special equipment for recovery of nosecones and data capsules and to collect weather data. Range Instrumentation Ships operate in the South Atlantic near Ascension and St. Helena. They occasionally make trips to the Indian Ocean for extremely long-range operations. Ports of call are Antigua, BWI; Trinidad; Recife, Brazil; Capetown and Durban, South Africa; and Ascension Island. The communications call name of this ship is WHISKEY.

Description of Ship:

C1-M-AV1 Characteristics

Length - 338 feet

Draft - 18 feet

Weight - 4000 gross tons

Propeller - Diesel 1700 hp

Main Generators - 2 dc, 300 kw each (may be paralleled to double capacity)

Cruising Speed - 10 knots

Range - 22,000 miles (max)

Auxiliary Equipment - Evaporator for manufacturing fresh water from sea water; air conditioning for instrumentation and living quarters; walk-in deep freeze compartment for frozen meats; chill boxes for fresh vegetables, eggs, etc; and a machine shop for small machine work.

Living Spaces - Crew's living spaces are under the bridge on the main deck (main deck is the first, or highest, complete deck on a ship). The ship's galley, crew's washrooms, and ship's laundry are in this area. The laundry is located in the crew's quarters area in a small compartment aft of the crew's messroom.

The engineering officers' quarters are also on the main deck, beneath the bridge, on the port side. The deck officers' quarters are on the first level above the engineering officers' quarters. The officers' messroom is also on this level and is used by the ship officers and PAA/RCA personnel. The captain's quarters are on the next level above deck officers' quarters. The captain's office and quarters are together on this level.

The PAA/RCA living quarters are mid-ship below the main deck. Staterooms each have bunks, storage lockers, and drawer space for two persons. A shower and head is between each two staterooms, with access from each side. The rooms are air conditioned and have no portholes. A recreation room is also located on this level. It has tables, bookcases, and lounging furniture. This room is for the ship's officers, the crew, and PAA/RCA personnel.

RCA personnel	-	8
PAA personnel	-	4
Ship's Crew	-	<u>40</u> (MSTS)
Total		52

This ship is equipped with the following systems and instrumentation:

A. TELEMETRY SYSTEM

The telemetry signal transmitted from an airborne missile is picked up on a 7-turn helical/broadband antenna and is coupled to one or more of nine receivers through preamplifiers and multicouplers. Each receiver has three outputs: signal strength, frequency, and telemetry intelligence. Signal strength and frequency outputs are recorded on graphic recorders; telemetry intelligence on magnetic tape recorders. Both types of instruments record timing signals along with data, to provide time-correlation.

After the telemetry data is collected, it is packed in locked cases and shipped to RCA Data Processing at Patrick AFB. This data, when collected, is unclassified because it is "raw" or unrelated.

B. COMMUNICATIONS SYSTEM

Communications equipment is provided for direct communications to Cape Kennedy and PAFB so that the flight schedules and other information may be furnished the telemetry operations. Communication from the ship to aircraft is also a necessity.

C. TIMING SYSTEM

A timing code is generated from a master frequency standard that is calibrated and synchronized with Bureau of Standards Station WWV.

1. INSTRUMENTATION SUMMARY

- 1 - Sounding Navigational Radar Set, AN/UQN-1 (Sonar), EDO Corp, Model 185
- 1 - Precision Depth Sounding Recorder
- 1 - Wind Measuring Set, AN/GMQ-11
- 1 - Navigation Radar Set, AN/SPN-18, CR 104
- 1 - Telcar (Telemetry Carrier and Recovery DF) Direction Finding System
- 1 - Ship Timing System, Model 36800, 17 Digit
- 1 - Telemetry 7-Turn Single Helical Antenna
- 2 - Omnidirectional Telemetry Antenna, Holloway H.10050-2
- 2 - Houston Fearless Pedestal, RCP-6, 45° Elevation for 7-Turn Helix
- 2 - Antenna Control Unit for 7-Turn Helix Pedestal (RCP-6)
- 1 - Single Strength Amplifier, Nems-Clarke Model SSA-100, with dual meters for comparing signal strength of telemetry receivers
- 2 - Teledome for 7-Turn Helix
- 1 - Telemetry Data Retransmission System, RT-100
- 4 - Preamplifier for 7-Turn Helix
- 3 - RF Distribution Amplifier, Nems-Clarke PR-203 Pre-amplifier and MC 406 Multicoupler
- 8 - Telemetry Receiver, Nems-Clarke Crystal Controlled Model 1401

2 - VHF-UHF (100-2300 mc) Telemetry Receiver, TMR-5A
Defense Electronics (not yet operational)

2 - Amplifier Chassis, Video Distribution with four amplifiers

3 - Telemetry Recorder, Magnetic 7-Track, 1/2 in. tape,
CEC Type 5-572, TLM 28

3 - Data Insertion Converter, TLM-8, Parsons and Hallamore
Electronic

2 - Mixer Monitor TLM 35

1 - Oscillograph Recorder, CEC 5-123, used with 6 each EMR
167 Discriminators as a Data Separation and Recording
System, EMR 56-7828

2 - Signal Strength Recorder, Direct Writing, 8-Channel,
Sanborn Model 150

1 - Receiver/Recorder Distribution Rack, TLM 20 Stromberg-
Carlson

2 - RF Monitor, Nems-Clarke, Model 1402F, part of TLM-15
Monitoring and Recording System

1 - DIC Calibrator and Discriminator, Multichannel; Air Pax,
TLM-121, and Electro Mechanical TLM-121A

6 - Discriminator, EMR 167, part of Data Separation and
Recording System, EMR 56-7828

1 - DIC Power Supply, New Jersey Elect, Model TR3-161

2 - Reference Oscillator, TLM-16, 100 kc Century

1 - Test Cart, CEC Model 23-203 for CEC 5-752 Recorder

2 - AN/FPN-13 Transmitter

1 - Broadband Telemetry Antenna (130-2300 mc)

1 - S-Band Telemetry Preamp Converter and Receiver System

2. COMMUNICATIONS EQUIPMENT

a. HF Radio

- 1 - HF-FRT 15 Transmitter
- 1 - HF-204 C Transmitter
- 3 - HF-JP 600 Receiver
- 1 - HF-R-390 Receiver

b. VHF Radio

- 1 - VHF 408A Transmitter
- 1 - VHF 51M2 Receiver

c. UHF Radio

- 2 - UHF T-282 Transmitter
- 3 - UHF R-361 Receiver

d. Teletype Equipment

- 1 - FGC 20 Teletypewriter
- 1 - FGC 52 Teletypewriter
- 1 - 152 Tone Converter
- 1 - 153 Tone Keyer
- 1 - TT 107 Reperforator

II. POTENTIAL FOR MEETING CURRENT AND FUTURE NEEDS

During Calendar Year 1965 this vessel will undergo shipyard modification. The following instrumentation is programmed for installation as indicated:

Marine Modification for Instrumentation of Coastal Crusader	ROD FY 66
S-Band Telemetry Preamplifier Frequency Converter/Data Receiver System	ROD FY 65
TDM Test Set	ROD FY 65
Glotrac Shipboard Station	ROD FY 65
Digital to Analog Conversion System	ROD FY 65
High-Speed Data Transmission System	ROD FY 67
Antenna Autotrack, Medium Gain	ROD FY 66
Improved HF Transmitting Antenna System	ROD FY 66
Modifications of the vessel to receive instrumentation equipment FY 65	
Installation of S-Band Telemetry	
Improved Communications	
Additional Quarters	
Other Minor Modifications	

Modifications of the vessel to receive instrumentation equipment FY 66

Installation Communications Interface

High-Frequency Radio Data Transmission

Minor Modifications

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